SureSigns VM Series
Patient Monitors

INSTRUCTIONS FOR USE

Release A.02

English

PHILIPS

Notice

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Printing History

New editions of this document incorporate all material updated since the previous edition. Update packages may be issued between editions and contain replacement and additional pages to be merged by a revision date at the bottom of the page. Pages that are rearranged due to changes on a previous page are not considered revised.

The documentation printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates that are incorporated at reprint do not cause the date to change.) The document part number changes when extensive technical changes are incorporated.

First Edition. . . . . .January 2011

Conventions

This guide uses the following conventions for Notes, Cautions, and Warnings.

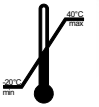
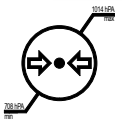
Note — A **Note** calls attention to an important point in the text.

Caution **A Caution calls attention to a condition or possible situation that could damage or destroy the product or the user's work.**

Warning **A *Warning* calls attention to a condition or possible situation that could cause injury to the user and/or patient.**

Explanation of Symbols

The following symbols appear on the monitor and its packaging.

Symbol	Description	Symbol	Description
CE 0123	CE mark	SN	Serial number
Rx Only	Prescription Use Only (US Federal Law)	LOT	Batch code
REF	Catalog number	ECG	ECG connector
	Manufacturer's name and address	 2010-10	Date of manufacture
	Fragile, handle with care		Temperature limitation
	Keep dry		Keep upright
	Atmospheric pressure limitation		Humidity limitation
	RF interference	IBP	IBP connector

Symbol	Description	Symbol	Description
	Main Screen key		Alarm silence key
	Trend key		NBP key
	On/Standby key		Print key
	SpO_2 connector		NBP connector
	CO_2 input connector		CO_2 output connector
	Caution, consult accompanying documents		Temperature connector
	Charging LED		AC power LED
	Compliance with WEEE standard		USB port
	Nurse call connector		Option number
100-240V ~ 50/60Hz 120VA  T 1.6 A 250V	Input power and fuse rating		Ethernet port

Symbol	Description	Symbol	Description
ICES-001	Canadian ISM requirement		Defib Sync port
	Protective earth (ground)		Equipotential grounding post
	Defibrillator Proof Type CF applied part		CSA mark
IPX1	Ingress protection against vertically falling water drops		Dangerous Voltage

Regulatory and Safety Specifications

Declaration

CE 0123

The VM4, VM6, and VM8 monitors are Class IIb devices and comply with the requirements of the Council Directive 93/42/EEC of 14 June 1993 concerning medical devices and carry CE-marking accordingly.

Authorized EU Representative

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Rx Only

Caution **United States Federal Law restricts this device to sale by or on the order of a physician.**

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Contents

14. VSV Networked Monitoring

15. Care and Cleaning

16. Accessories List

17. Specifications

1
Overview

This chapter provides a brief overview of the SureSigns® VM Series patient monitors.

Warning **Before each use, inspect the monitor and accessories for deterioration or damage. Replace any damaged equipment or report it to your system administrator.**

Note — This document includes information on functions and features which are not available on all SureSigns VM Series monitors or may only be available in selected regions. For information specific to your region, please contact your local Philips representative.

The SureSigns VM4, VM6, and VM8 patient monitors are easy to use as well as versatile. The SureSigns VM Series offers several configurations and optional features to best suit your needs.

The user interface is designed for fast and intuitive operation and the large screens allow for easier viewing. Features include:

- Adult, pediatric, and neonatal capability
- Lithium ion battery
- 8.4" or 10.4" color screen
- Stores up to 100 patient records (VM4 in SpotCheck mode only)
- Stores up to 96 hours of trend data
- Flexible blood pressure modes
  - Manual start/stop
  - Auto intervals
- SpO_2 waveform
- Optional recorder
- Optional roll stand, wall mount, or bedrail hook
- Optional barcode scanner for Patient ID entry
- LAN and serial data export

Indications for Use

The SureSigns VM4, VM6, and VM8 patient monitors are for use by health care professionals whenever there is a need for monitoring the physiological parameters of patients.

Standard and optional parameters include:

•ECG

•Respiration

•NBP

•SpO_2

•IBP

•CO_2

•Temperature

Intended Use

The SureSigns VM4, VM6, and VM8 patient monitors are for monitoring, recording and alarming of multiple physiological parameters of adults, pediatrics, and neonates in healthcare environments. Additionally, the monitor is intended for use in transport situations within a healthcare facility.

SureSigns VM Monitor Configurations

The SureSigns VM Series includes several configurations. The following table lists the three models, the standard features in each model, as well as optional features. In the table, a solid circle indicates a standard feature and a hollow circle indicates an optional feature.

	SureSigns VM4	SureSigns VM6	SureSigns VM8
NBP	•	•	•
SpO_2	•	•	•
ECG	• 3 lead	• 3 and 5 lead	• 3 and 5 lead
Respiration	•	•	•
Arrhythmia Analysis		•	•
IBP		o	•
Predictive temperature	o		
Continuous temperature		•	•
CO_2			o
Recorder	o	o	o
Display	8.4 inches	8.4 inches	10.4 inches
Max. number of waveforms	3	4	4

What's New in Release A.02?

Release A.02 of the SureSigns VM Series patient monitors includes the following features and enhancements.

Respiration on VM4 Monitor

Respiration measurements are now available on the VM4 patient monitor. Previously, respiration measurements were available only on VM6 and VM8 patient monitors.

For more information, see Chapter 10, "Monitoring Respiration."

Apnea Alarming

The VM Series patient monitors now support apnea alarming.

For more information about configuring apnea alarm settings, see Chapter 9, "Monitoring Carbon Dioxide" and Chapter 10, "Monitoring Respiration."

Philips Non-Invasive Blood Pressure Module

The VM Series patient monitors now support a Philips NBP hardware module. Previously, these monitors contained a CAS NBP module.

You can easily identify which type of NBP module is in your monitor by viewing the **System Menu**. For more information, see "Identifying the NBP Hardware Module" on page 5-15.

Note — If your facility has VM Series monitors that contain CAS NBP hardware modules, see Appendix C, "NBP Module Comparison" for details about the differences between the CAS and Philips NBP modules.

CO_2 Monitoring Enhancements

The VM8 monitor with optional CO_2 uses a new CO_2 module and Smart Alarm Respiratory Analysis (SARA) alarm management technology. The procedures for measuring CO_2 have not changed.

You can easily identify which type of CO_2 module is in your monitor by viewing the **System Menu**. For more information, see "Identifying the CO2 Hardware Module" on page 9-12.

Additional Patient ID Input Fields

The **New Patient Menu** now contains the following patient ID input fields:

- **MRN** (Medical Record Number)
- **Transaction ID** (visit ID)
- **First Name**, **Middle Name**, **Last Name**
- **Location ID**
- **Operator ID**

For more information, see "Patient ID Overview" on page 2-18.

Enhanced Barcode Scanning Option

If your facility uses barcodes, you can now enter multiple patient identifiers by scanning several barcodes. The monitor prompts you to scan the barcode for each patient ID. Previously, the scanned barcode was automatically entered only in the **Patient ID** or **Bed ID** field.

For more information about scanning patient IDs, see "Entering Patient IDs by Scanning Individual Barcodes" on page 2-21 and "Entering Patient IDs with a Programmed Barcode Scanner" on page 2-24.

Speaker Malfunction Notification

If the speaker in your monitor is not working, a message, **Speaker Malfunc**, appears in the alarm message area and **AUDIO FAILED** appears in the main screen. Previously, no notification appeared if the speaker was not functioning.

For more information, see "Speaker Malfunction Notification" on page 3-5.

Time Synchronization

Your system administrator can configure your VM Series monitor to automatically synchronize the clock on the monitor to the clock on your hospital EHR server or HL-7 interface server.

For more information, see "Synchronizing the Date and Time" on page 2-25.

Serial Data Export

The optional USB to RS-232 serial adapter allows you to export patient data over an RS-232 serial connection. Previously, you could only export patient data over a LAN connection.

Exporting/Importing Configuration Settings

Your system administrator can now save a copy of the VM monitor configuration settings to a USB flash drive. The settings can be imported into other monitors with the same hardware configuration and software revision.

Tool Tips

When you rotate the navigation wheel to highlight a button on the main screen, a description of the button, or "tool tip," appears.

Options for Printing Waveforms

The **Waveform Print** setting determines the length of printed waveforms. You can select **20 seconds** or **7 seconds** in the **System Menu**.

For more information, see "Printing Options" on page 12-3.

Heart Rate Alarm Limits

The **Heart Rate Menu** and **Alarm Menu** now contain three separate Heart Rate alarm limit settings, based on the Heart Rate source:

- **HR (ECG)**
- **HR (SpO2)**
- **HR (NBP)**

Previously, only one Heart Rate alarm limit setting was available.

For more information about Heart Rate alarm limit settings, see Appendix B, "Alarm Specifications."

New and Updated Technical Alarms

The following technical alarms are new or have been updated in Release A.02:

- **CO2 Occlusion**
- **Date / Time Adjusted**
- **HR = RR**
- **Speaker Malfunc**
- **SpO2 Extd Update**
- **SpO2 Low Perf**
- **Temp Module Malfunc**
- **Temp Probe Error**

For more information about these messages, see Appendix B, "Alarm Specifications."

SureSigns VM Series Documentation

SureSigns VM Series documentation includes:

- ***SureSigns VM Series Installation and Configuration Guide***: Provides instructions for unpacking, installing, and connecting all hardware. Includes initial testing and configuration procedures. Also includes instructions for returning the monitor.
- ***SureSigns VM Series Instructions for Use***: Provides information for day to day operation of the VM Series monitors. Also includes safety information, monitor specifications, and compatible accessories.

Note — For information about purchasing additional copies of the *SureSigns VM Series Instructions for Use*, contact the Philips Customer Care Center.

- ***SureSigns VM4 Quick Card*** and ***SureSigns VM6 and VM8 Quick Card***: Provides brief descriptions of commonly used VM Series functions.
- ***SureSigns VM Series Service Guide***: Provides instructions for repairing and testing the monitor. Includes assembly diagrams, spare parts lists and troubleshooting information.
- ***SureSigns VM Series Data Export Guide***: Provides detailed information about the HL7 data export feature, including HL7 message syntax and procedures for exporting HL7 data from the monitor.

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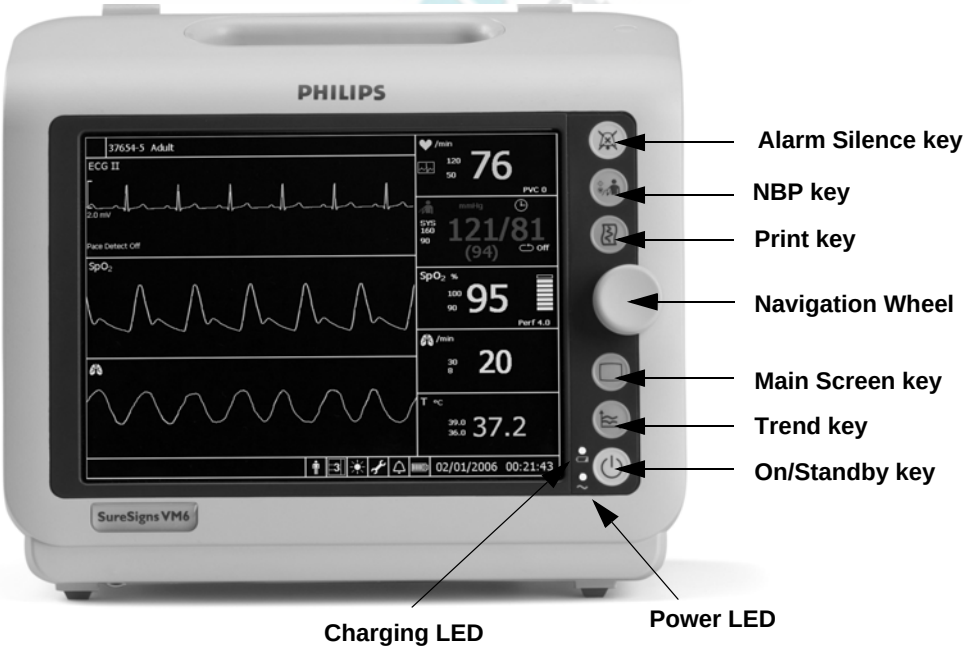
2
Basic Operation

This chapter describes how to begin using your SureSigns VM Series monitor.

For information about setting up and configuring the monitor, see the *SureSigns VM Series Installation and Configuration Guide* on the *SureSigns VM Series Service Documentation CD*.

The Front Panel

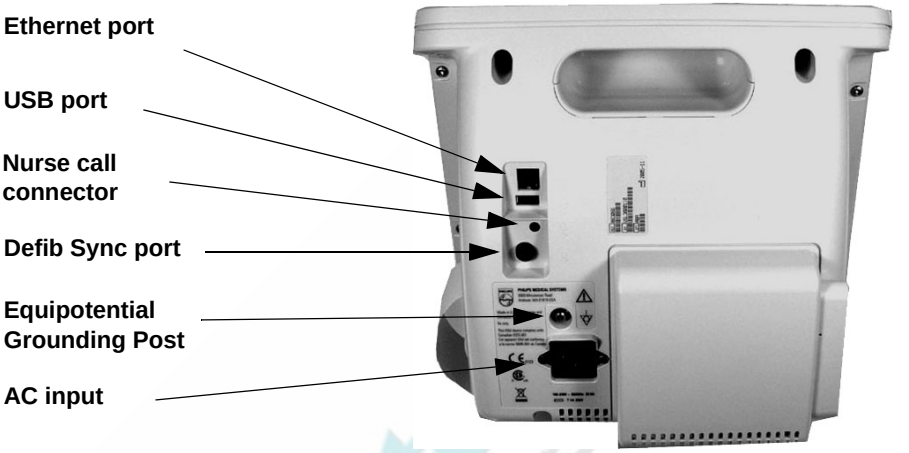
All function keys and LEDs are on the monitor's front panel. The following illustration and table describe these controls.



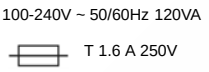
Control	Icon	Description
Alarm Silence key		Press once to pause alarms for 60 seconds; press two times quickly to pause alarms for a specified period of time; press and hold for 2 seconds to initiate Audio Off mode. To turn audio alarms back on, press the **Alarm Silence** key.
NBP key		Press to initiate a single NBP measurement or to start the first measurement of an NBP interval. If an NBP measurement is underway and you press this key, the measurement stops.
Print key		Press to produce a printout of patient data. The information provided on the printout is based on the type of data currently displayed on the screen.
Navigation wheel		Use the navigation wheel to select and change various settings.
Main Screen key		Press to quickly exit from a screen and return to the main monitoring screen. Press two times quickly to freeze an ECG waveform.
Trend key		Press to open the Trend display.
On/Standby key		Press once to turn the monitor on. Press again to enter Standby mode. In Standby mode, the display is blank and all monitoring ceases, but the monitor does not actually turn off.
Power LED		When lit, indicates that the monitor is connected to an AC power source.
Battery Charging LED		Changes color based on the charging status of the battery. For more information, see “Charging the Battery” on page 2-6.

The Rear Panel

The following illustration and table describe the connectors on the back of the monitor.



Connector	Description
Ethernet port	10/100 Base-T Ethernet port used for: • LAN data export • Connecting the monitor to the SureSigns VSV network For more information, see your system administrator.
USB port	Standard USB 1.1, 4-pin connector used for: • The optional barcode scanner • Data export through the optional serial interface adapter • Software upgrades • Export trend data from the **Tabular Trend Menu** • Export and import of configuration settings For more information, see your system administrator.

Connector	Description
Nurse call connector 	3.5 mm phone jack for connection to a nurse call system.
Defib Sync port 	For synchronized cardioversion. For more information, see Appendix A, “Defib Sync.”
Equipotential Grounding Post 	For facilities that require a potential equalization connection.
AC input connector 	Plug the AC power cord into the AC input connector.

Setting up the Monitor

This section describes how to power up the monitor, charge the battery, and change the system date and time.

Powering Up

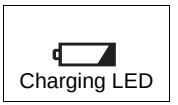
The monitor will operate on AC power or the internal battery.

To power up the monitor:

Step	
1	Connect the power cord to the receptacle on the monitor's rear panel and to an AC power source.
2	Ensure that the AC outlet is properly grounded and supplies the specified voltage and frequency (100 – 240 VAC, 50 – 60 Hz). **Note —** *Within the U.S., a hospital-grade outlet is recommended.*  Power LED The green power LED on the front panel lights when the AC power source is connected. Also, the battery indicator on the front panel indicates the current status of the battery. For more information, see "Charging the Battery" on page 2-6.
3	 On/Standby key Press the **On/Standby** key. The monitor powers up and performs a self-test. During this self-test, the monitor also tests the speaker; listen for an audible tone to confirm that the speaker is working properly. To verify the speaker is working at any time, see "Testing Alarms" on page 3-17. You may also be prompted to change the system date and time the first time you power up the system. For more information, see "Changing the System Date and Time" on page 2-7.

If your facility requires a separate potential equalization connection, use the grounding post on the rear of the monitor. Connect a grounding cable from the post to the grounding system in your facility.

Charging the Battery

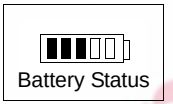


Any time the monitor is connected to AC power, the battery is being charged. When you first receive the monitor, the battery charge may be low. You should connect the monitor to an AC power source before using it on battery power alone.

Note — To ensure that the battery is sufficiently charged, keep the monitor plugged in to AC power when it is not in use.

The Charging LED on the front panel provides the charging status of the battery. The color of the LED tells you how much charge remains on the battery:

- **Green**: The battery is at least 90% charged.
- **Flashing Green:** More than 30% charge, but less than 90%.
- **Yellow:** More than 21% charge, but less than 30%. This battery status triggers the **Low Batt** technical alarm.
- **Flashing Yellow:** Less than 21% charge. This battery status triggers the **Extreme Low Batt** technical alarm.



The battery status pane on the bottom of the main screen also indicates battery status.

If the monitor is connected to AC power, and the power cord is then disconnected, the monitor automatically resorts to battery power, if the battery is sufficiently charged. All alarm settings are preserved.

Warning **Dispose of used batteries in an environmentally responsible manner. Do not dispose of the battery in normal waste containers. Consult your system administrator to find out about local arrangements.**

Changing the System Date and Time

Use the following procedure to change the system date and time. If the **Date / Time Menu** is already open, skip to step 3.

Note — The following conditions apply to the system date and time.

- If the monitor is networked and your system administrator has enabled time synchronization, the monitor date and time are automatically synchronized with the server clock.
- If the monitor is connected to a VSV, see Chapter 14, “VSV Networked Monitoring” for information on synchronizing the monitor’s date and time with the VSV.
- The date and time cannot be changed while the monitor is printing or an NBP measurement is in progress. Also, if you are using a VM4, the date and time cannot be changed while a patient record is open or a temperature measurement is in progress.
- The system clock does not adjust for daylight savings time. You must manually change the time.

To change the system date and time:

Step	
1	Rotate the navigation wheel until the date and time pane is highlighted. The date and time pane is in the lower right corner of the main screen.
2	Press the wheel. The **Date / Time Menu** appears.
3	Rotate the wheel until the value you want to change is highlighted.
4	Press the wheel and rotate it until the desired value appears.
5	Press the wheel again to save the new value.

6	Repeat step 3 through step 5 to change other values in the menu.
7	Rotate the wheel until the **Apply** button is selected and press the wheel to save your changes and close the menu. **Note —** *A blue line appears in the graphical and tabular trend displays to indicate when the date/time adjustment occurred.*

You can change the date format (**mm/dd/yyyy** or **dd/mm/yyyy**) and you can hide the time display using options in the **System Menu**. For details, see "Changing System Settings" on page 2-26.

On/Standby Mode

If you press the **On/Standby** key while the monitor is On, the monitor goes into Standby mode and the following occurs:

- The display goes blank.
- Battery charging continues if the monitor is connected to an AC power source.
- SpotCheck records and trend data remain in memory.
- Monitoring stops.
- If your monitor is connected to a VSV, patient data is not sent to the VSV. The message **No Data From Bed** is displayed at the VSV.

To resume monitoring, press the **On/Standby** key.

Deep Sleep Mode

The monitor enters Deep Sleep mode when:

- The monitor is not connected to an AC power source and it remains in Standby mode for more than 30 minutes or the battery level drops below 30%.
- The monitor is on, but not connected to an AC power source, and the battery level drops below 12%.

In Deep Sleep mode, the display is blank and the system uses minimal power to maintain the system clock. No measurements are taken, and no alarms sound.

To resume normal monitoring, connect the monitor to an AC power source and press the **On/Standby** key to turn the monitor back On.

If you start a new patient, all trend data is cleared and the alarm settings are restored to default values; if you choose not to start a new patient the alarm settings remain as they were before the monitor went into Deep Sleep mode and the trend data remains in memory.

Mounting the Monitor

You can mount the monitor using a variety of mounting accessories, including:

- Bedrail hook
- Roll stand
- Wall mount

To use the bedrail hook, place the hook over a secure horizontal bedrail. Do not place the monitor in a position where the patient or staff could inadvertently knock it off the bed.

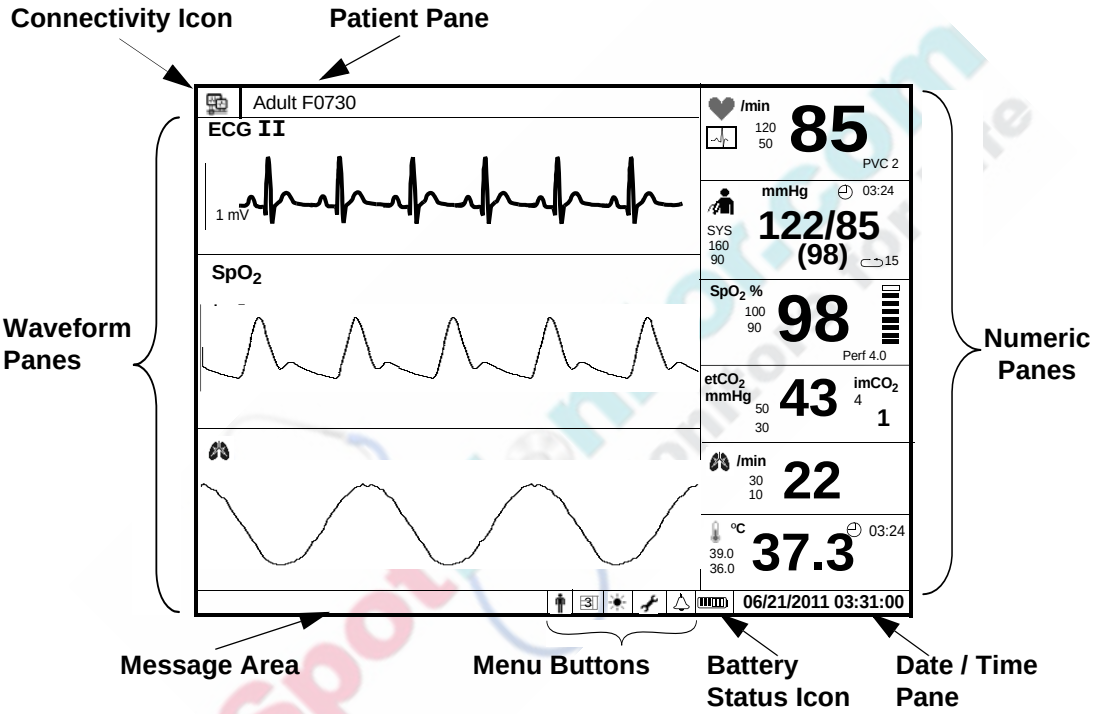
Caution **If your monitor is mounted on a roll stand, use the handle on the roll stand to move the monitor. Do not use the monitor handle to move the monitor; doing so, creates stress on the mounting bracket and could cause the monitor to fall off the roll stand.**

Note — The weight of objects placed in the basket of the roll stand must not exceed 3.6 kg (8 lb).

For information on mounting the monitor on the roll stand or wall mount, see the *Instructions for Use* that comes with the mounting hardware.

Main Screen Display

Note — The illustration in this section shows the main screen on a fully configured monitor.



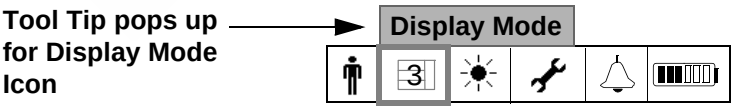
The main screen contains the following basic elements:

- The **connectivity icon** appears if the monitor is connected to a SureSigns VSV network, as described in Chapter 14, “VSV Networked Monitoring.”
- The **patient pane** at the top of the screen displays the current patient ID and patient type. If you do not enter a patient ID, the text **ID Unknown** is displayed. If the monitor is connected to a VSV, the patient pane also displays the patient name and monitor name.
- **Numeric panes** display measurements as numeric values. Some of the measurements in the numeric panes also have corresponding waveforms. For example, the SpO_2 measurement can be displayed as both a numeric value and a waveform.
- **Waveform panes** display real-time waveforms for the following measurements: ECG, SpO_2, CO_2, IBP, and Respiration.
- The **message area** displays short text descriptions of all active alarms. High-priority alarms pre-empt low-priority alarms. Once the high-priority alarm has been resolved, the low priority alarm message appears. If multiple alarms of the same priority occur at the same time, the alarm messages rotate every 1.5 seconds.
- **Menu buttons** are used to open menus to change various system settings.
- The **Battery Status** icon shows the current charging status of the monitor’s battery.
- The **Date / Time pane** displays the current date and time. You can hide the time, as described in “Changing System Settings” on page 2-26.

The placement of these screen elements is determined by the display mode you choose. See the next section, “Changing the Display Mode,” for more information.

Tool Tips

When you rotate the navigation wheel to highlight an icon in the main screen, a description of the highlighted icon pops up, as seen in the following illustration.



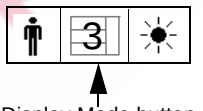
Changing the Display Mode

You can change the appearance of the main screen by selecting a layout from the **Display Mode** menu. Available layout choices depend on your monitor's configuration. The following display modes are available:

- **Big number** (All models) — One ECG waveform appears in the upper left corner of the screen and numeric panes appear in the remainder of the screen. This display mode is a good choice if you must read the screen from a distance.
- **3 waveform** (All models) — Three waveforms appear on the left side of the screen and numeric panes appear on the right side.
- **4 waveform** (VM6 and VM8) — Four waveforms appear on the left side of the screen and numeric panes appear on the right side.
- **SpotCheck** (VM4 only) — The SpotCheck display mode contains four numeric panes and a patient records table, which displays the records in the SpotCheck database. For more information, see Chapter 13, "SpotCheck Mode."

Note — If your monitor does not have all of the optional parameters, the bottom waveform is blank.

To change the display mode:

Step		
1		Rotate the wheel until the **Display Mode** button is highlighted. **Note —** *The button changes, depending on which mode is currently active.*

2	Press the wheel. The **Display Mode** menu appears and the currently active display mode is highlighted.
3	Turn the wheel to select a display mode and press the wheel again. The new display mode is active.

Changing the Position of a Waveform

Use the following procedure to change the order in which the waveforms appear on the main screen.

The **Select Waveform** option — which appears in each waveform's pop-up menu — contains a list of all available waveforms. Available waveforms are based on your monitor configuration; if your monitor is not configured for a particular measurement, for example CO_2, that measurement is not available in the **Select Waveform** list.

Note — Only one instance of a waveform type can be displayed at one time. The exception is ECG waveforms. Also, one ECG waveform always appears in the top position. For more information, see "ECG Waveforms" on page 2-14.

If your monitor is connected to a VSV, see "Selecting a VSV Waveform" on page 14-8 for information on displaying waveforms at the VSV.

To change the position of a waveform:

Step	
1	Rotate the wheel until the waveform you want to change is highlighted.
2	Press the wheel. The configuration menu for the selected waveform appears.

3	Turn the wheel until the **Select Waveform** option is selected, then press the wheel to display a list of all available waveforms (based on monitor configuration): **ECG I**, **ECG II**, **ECG III**, **ECG aVR**, **ECG aVL**, **ECG aVF**, **ECG V**, **ECG MCL**, **SpO2**, **CO2**, **ABP, CVP, PAP**, and **RESP**.
4	Turn the wheel to select the waveform type that you want to display in the selected pane and press the wheel again. The waveform menu closes and the waveform menu for the newly selected waveform appears.
5	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

ECG Waveforms

The top waveform pane is always reserved for ECG.

The VM6 and VM8 monitors can display two ECG waveforms at one time, if the **ECG Lead Set** option is set to **5 Lead**.

The choices in the **Select Waveform** list are based on the current lead type:

- 3-electrode lead set: **ECG I**, **ECG II**, or **ECG III**
- 5-electrode lead set (available on the SureSigns VM6 and SureSigns VM8): **ECG I**, **ECG II**, **ECG III, ECG aVR**, **ECG aVL**, **ECG aVF**, **ECG V**, or **ECG MCL**

Changes to the sweep speed of one ECG waveform apply to all of the displayed ECG waveforms.

Changing the Waveform Speed

The **Sweep Speed** setting — which appears in each waveform's pop-up menu — determines the speed at which the wave is drawn across the screen. Decreasing the wave speed compresses the wave, allowing you to view a longer time period. Increasing the wave speed expands the waveform, giving you a more detailed view.

To change the speed of a waveform:

Step	
1	Rotate the wheel until the waveform whose speed you want to change is highlighted.
2	Press the wheel. The configuration menu for the selected waveform appears.
3	Rotate the wheel until the **Sweep Speed** option is selected, then press the wheel to display a list of options. The **Sweep Speed** options are different for each waveform.
4	Rotate the wheel to select a sweep speed, and then press the wheel again.
5	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the Brightness of the Display

Brightness button

If the display is too bright or too dark, you can adjust the brightness in the **Backlight Menu**.

To adjust the brightness:

Step	
1	Rotate the wheel until the **Brightness** button is highlighted.
2	Press the wheel. The **Backlight Menu** appears.
3	Rotate the wheel until the **Brightness** option is highlighted.
4	Press the wheel and rotate it to select a brightness level. **1** is the darkest setting and **5** is the brightest.
5	Press the wheel to save the new brightness value.
6	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Starting a New Patient

New Patient button

When you admit a patient, you can use the **New Patient Menu** to enter information about the patient.

The current patient ID and patient type are displayed in the top left corner of the main screen and in the header on all printouts you generate with the optional recorder.

You do not have to enter a patient ID before you begin monitoring. If you choose not to enter an ID, the text **ID Unknown** appears in the display.

This section describes how to enter patient IDs and select a patient type in normal monitoring mode. For information on starting a new patient in SpotCheck mode, see Chapter 13, “SpotCheck Mode.”

Caution **When you start a new patient, all trend data is cleared, and all alarm limits and NBP settings, including Initial Inflation Pressure and Intervals, are set to their default values.**

Note — If your monitor is connected to a VSV, see Chapter 14, “VSV Networked Monitoring” for information on entering patient IDs.

Patient ID Overview

Your system administrator configures your monitor to display any or all of the following patient ID input fields in the **New Patient Menu**:

- Medical Record Number (**MRN**): A unique number used to track and identify a patient. Maximum length is 20 characters.
- **Transaction ID**: Also known as a visit ID, the transaction ID is a unique number used to track a single patient visit. Maximum length is 20 characters.
- **First Name**, **Middle Name**, **Last Name**: The patient's name. Maximum length is 15 characters for each name field.
- **Location ID**: Typically, a description of the physical location of the VM monitor, for example a room number. Maximum length is 12 characters.

Note — If the monitor remains in one location, your system administrator can configure a default Location ID so that you do not have to manually enter a Location ID each time you start a new patient.

- **Operator ID**: The ID of the person using the monitor to measure a patient's vital signs. Maximum length is 12 characters.

The available patient ID input fields can only be changed by your system administrator in the password-protected **System Admin Menu**.

In this guide, the term *Patient ID* is used to refer to any of the patient ID types listed above.

Caution **Before you begin monitoring, make sure that the correct patient type is selected. The default alarm limits are based on the selected patient type.**

Primary Patient ID

Your system administrator also configures a primary ID. The primary ID must be either the **MRN**, **Transaction ID**, or **Location ID**.

An asterisk appears next to the selected primary ID in the **New Patient Menu**. To save a record with an ID, you must enter information in the selected primary ID field. If you do not enter information in the primary ID field, the record will be saved as **ID Unknown**.

Enabling/Disabling the New Patient Menu

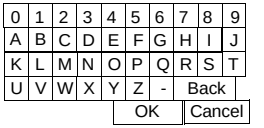
To open the **New Patient Menu**, select the **New Patient** button at the bottom of the main screen.

By default, the **New Patient Menu** appears only when you explicitly choose to open it, or when you take the monitor out of SpotCheck Mode (VM4 only). To specify that the **New Patient Menu** automatically opens when the monitor is taken out of Standby Mode or Deep Sleep Mode, open the **System Menu** and select **Yes** in the **Enable New Patient Menu** option.

Entering Patient IDs Using the On-screen Keyboard

Note — If your system administrator has enabled barcode scanning on your monitor, the on-screen keyboard is not available.

To manually enter patient identifiers:

Step	
1	 New Patient button Rotate the wheel until the **New Patient** button is highlighted.
2	Press the wheel. The **New Patient Menu** appears.
3	If the patient type is correct, go to step 4. To change the patient type, rotate the wheel to highlight the **Patient Type** field and press the wheel. Rotate the wheel to select a patient type. The choices are: • **Adult** • **Pediatric** • **Neonatal** Press the wheel again to save the selected patient type.
4	Rotate the wheel until the primary ID field is selected and then press the wheel. A small keyboard appears. 

5	Rotate the wheel to select a character and press the wheel after each selection. If you enter an incorrect character, use the **Back** button to erase the character or use the **Cancel** button to start over. When you are done entering the patient ID, rotate the wheel to select the **OK** button on the keyboard and press the wheel.
6	Enter IDs in any additional patient ID fields, if required.
7	Rotate the wheel until the **OK** button is selected and press the wheel to close the **New Patient Menu**.

Entering Patient IDs by Scanning Individual Barcodes

If your barcode scanner reads individual barcodes one at a time, the monitor prompts you to scan each patient ID. The scanned information is transferred to the highlighted patient ID field on the monitor.

Before you begin scanning, be sure that you are familiar with the barcodes used at your facility. When the monitor prompts you to scan a patient ID, you will need to know which barcode corresponds with the highlighted ID field.

To scan individual patient ID barcodes:

Step	
1	Hold the scanner over the barcode, pull the trigger, and center the beam on the barcode. **Note —** To get a proper read: • Hold the scanner closer to small barcodes and farther away from large barcodes • Ensure that the patient's wrist band is lying flat and the barcode is visible • Ensure that the barcode is not damaged • Pause for at least one second between scans The **New Patient Menu** opens and the first enabled patient ID field is highlighted. **Alternative:** Open the **New Patient Menu** by rotating the wheel to highlight the **New Patient** button and pressing the wheel.
2	Verify that the correct patient type (**Adult**, **Pediatric**, or **Neonatal**) is selected. If necessary, change the patient type by rotating the wheel to highlight the **Patient Type** field and press the wheel. Select the appropriate patient type and press the wheel again to save your selection.
3	Rotate the wheel until the first enabled patient ID field is highlighted. A message at the bottom of the screen prompts you to scan the patient ID.
4	Hold the scanner over the barcode, pull the trigger, and center the beam on the barcode. The scanned ID appears in the corresponding patient ID field, and the next enabled field is highlighted. A message at the bottom of the screen prompts you to scan the next patient ID.

5	Repeat step 4 to scan each barcode. **Note —** *If your system administrator has configured a default Location ID, the monitor does not prompt you to scan the Location ID and skips to the next patient ID field. You can change the default Location ID by rotating the wheel, highlighting the* **Location ID** *field, and rescanning the Location ID barcode.* After the last patient ID field is entered, the **OK** button is highlighted.
6	Verify that the scanned information is accurate.
7	Press the wheel to close the **New Patient Menu**.

Entering Patient IDs with a Programmed Barcode Scanner

If your barcode scanner is programmed, the scanned information is automatically transferred to the corresponding patient ID fields on the monitor.

Before you begin scanning, make sure you are familiar with the barcodes used at your facility.

To use a programmed barcode scanner to scan patient IDs:

Step	
1	Hold the scanner over the barcode, pull the trigger, and center the beam on the barcode. **Note —** To get a proper read: • Hold the scanner closer to small barcodes and farther away from large barcodes • Ensure that the patient's wrist band is lying flat and the barcode is visible • Ensure that the barcode is not damaged The **New Patient Menu** appears and the scanned patient identifiers appear in the corresponding patient ID fields. **Alternative:** Open the **New Patient Menu** by rotating the wheel to highlight the **New Patient** button and pressing the wheel.
2	Verify that the correct patient type (**Adult**, **Pediatric**, or **Neonatal**) is selected. If necessary, change the patient type by rotating the wheel to highlight the **Patient Type** field and press the wheel. Select the appropriate patient type and press the wheel again to save your selection.
3	If necessary, hold the scanner over the next barcode, pull the trigger, and center the beam on the barcode. The scanned identifiers appear in the corresponding patient ID fields.

4	Verify that the scanned information is accurate.
5	Rotate the wheel until the **OK** button is highlighted and press the wheel to close the **New Patient Menu**.

Networked Monitors

If your monitor is configured to export data to the EMR, the records in the Tabular Trend display change from white to green after they have been exported; if the records do not change from white to green, see your system administrator for assistance.

Caution **If you are using the optional serial interface adapter to export data and you disconnect the adapter to move the monitor to a different location, make sure the black sheath completely covers the RS-232 connector after you reconnect the cable.**

Synchronizing the Date and Time

If your monitor is configured to export patient data to a hospital EHR server or HL-7 interface server, your system administrator can configure the monitor to automatically synchronize the clock on the monitor to the clock on the server.

If the clock on the monitor differs by more than 5 seconds from the clock on the server, the monitor will immediately adjust the date and time, unless:

- A SpotCheck record is open; the time change will occur after the record is closed.
- An NBP or temperature measurement is in progress; the time change will occur when the measurement is complete.
- The monitor is printing; the time change will occur after printing is complete.

If the time difference is greater than 30 seconds, the following occurs:

- A low priority technical alarm message, **Date / Time Adjusted**, appears and flashes in the monitor's message area.

Note — No audible alarm is associated with a **Date / Time Adjusted** alarm message. To clear the alarm, press the **Alarm Silence** key.

- A blue line appears in the graphical and tabular trend displays to indicate when the date/time adjustment occurred.
- In NBP Interval mode, the monitor adds an NBP measurement.

Note — If the system clock on the server adjusts automatically for daylight savings time, the monitor will synchronize with the server clock. If the system clock on the server does not adjust automatically for daylight savings time, you must manually change the time on the monitor.

Changing System Settings


System button

The **System Menu** contains several system settings, a display-only section that contains monitor-specific information, and a **System Admin** button that provides access to the password-protected **System Admin Menu**.

To change settings in the **System Menu**:

Step	
1	Rotate the wheel until the **System** button is highlighted.
2	Press the wheel. The **System Menu** appears.

3	Turn the wheel to select one of the following system settings: • **Recorder Speed** — If your monitor has a recorder, use this option to change the speed at which it prints. The lower the speed, the greater the resolution in the printed waveforms. The **Recorder Speed** options are: **50.0 mm/s**, **25.0 mm/s**, **12.5 mm/s**, and **6.25 mm/s**. **Note —** *The* **Recorder Speed** *setting is independent of the* **Sweep Speed** *settings for the various waveforms. In other words, the* **Sweep Speed** *setting does not affect the recorder output and vice versa.* • **Waveform Print** — Use this setting to select the length of printed waveforms. Options are **7 seconds** and **20 seconds**. For more information, see "Snapshot Printing" on page 12-3. • **ECG Lead Set** — This setting must match the actual ECG lead set connected to the monitor. The options are **5 Lead** and **3 Lead**. The 5 Lead option is not available in SureSigns VM4 models. • **Date Format** — You can change the monitor's date format. Options are **mm/dd/yyyy** and **dd/mm/yyyy**. • **VSV Waveform Display —** This setting is available if the monitor is connected to a VSV network. For more information, see Chapter 14, "VSV Networked Monitoring." • **Display Time —** Use this setting to show or hide the time in the lower right corner of the display. • **Enable New Patient Menu** — Select **Yes** or **No** to indicate whether or not the **New Patient Menu** opens automatically when the monitor is taken out of Standby or Deep Sleep mode. • **Default Patient Type** — Select a patient type. Each time you start a new patient, the default patient type is selected and the alarm settings are restored to the default values for the the specified patient type.

	• **Monitor Name** — The default monitor name is the monitor serial number. Use this field to change the default name to something more meaningful, for example, a room number or some other identifying information, especially if the monitor is connected to a VSV network. The **Monitor Name** can be up to 10 characters long. For more information, see Chapter 14, "VSV Networked Monitoring." • **System Admin** — Only qualified service personnel can open the **System Admin Menu**, which is password-protected. For more information on these settings, see the appropriate sections of this guide.
4	The following read-only system settings provide additional information about the monitor: • **Serial Number** — The monitor's serial number, which also appears on the back of the monitor. The serial number is configured in the factory. • **Hardware ID** — The version number for each of the following hardware components: *<Main Board> - <Front End Board> - <FPGA>* • **Software Version** — The software version installed on the monitor. • **LAN MAC Address** — The unique MAC address assigned to the monitor. The MAC address is configured in the factory. • **LAN IP Address** — The IP address currently assigned to the monitor. • **Language** — The language currently configured on the monitor. • **VSV Name** — If your monitor is connected to a VSV, this field displays the VSV name. • **Configuration** — The monitor type and the parameters installed in the monitor.
5	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Using the Monitor Safely

All of the patient applied parts on the SureSigns VM patient monitor are classified as type CF, which specifies their degree of protection against electrical shock. All are rated as defibrillator proof, as indicated by the heart symbol on the side panel.

This monitor is suitable for use in the presence of electrosurgery.

SureSigns VM Series patient monitors are suitable for use in all establishments, as defined by CISPR 11, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.

Ensure that the monitor is in working condition before clinical use. If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs by alternative means and then with the monitor to make sure it is working properly.

If you connect the monitor to any instrument, verify proper operation before clinical use. Refer to the instrument's Instructions for Use for full instructions.

Accessory equipment connected to the monitor's data interface must be certified according to EN/IEC 60950 for data-processing equipment or EN/IEC 60601-1 for electromedical equipment. All combinations of equipment must be in compliance with EN/IEC 60601-1-1 systems requirements.

Anyone who connects additional equipment to the signal input port or signal output port configures a medical system and is therefore responsible to ensure that the system complies with the requirements of system standard EN/IEC 60601-1-1. If in doubt, contact the Philips Customer Care Center or your local Philips representative.

The monitor and its accessories must be tested by qualified service personnel at regular intervals to ensure that performance has not been degraded by aging or environmental conditions. Periodic performance verification tests can be performed, as described in the *SureSigns VM Series Service Guide.*

Warning **Do not expose the monitor to extreme moisture, such as rain.**

Explosion Hazard. Equipment not suitable for use in the presence of a flammable anaesthetic mixture with air or oxygen or nitrous oxide. Oxygen concentrations must be <25% and partial pressure <27.5 kPa when no other oxidants are present.

Electric shock hazard. Covers should be removed only by qualified service personnel. There are no user-serviceable parts inside.

Do not touch the patient, or table, or instruments during defibrillation.

Measurement accuracy may decrease temporarily while performing electro-surgery or defibrillation. The recovery time is less than 10 seconds. This does not affect patient or equipment safety.

Do not open the monitor or attempt to change the battery. If you suspect a problem with parts within the monitor, contact your biomedical engineer or local Philips Representative.

Route patient cabling to reduce the possibility of patient entanglement or strangulation. To reduce this risk, Philips recommends the use of the cable management kit. For more information, see “Miscellaneous Accessories” on page 16-16.

Do not place the monitor in any position that might cause it to fall on the patient. Do not lift the monitor by the power supply cord or patient connections.

Do not use the monitor on more than one patient at a time.

To ensure patient electrical isolation, connect only to other equipment that provides patient electrical isolation.

Do not use extension cords to connect the monitor to electrical outlets.

Do not connect the monitor to an electrical outlet controlled by a wall switch or dimmer.

LAN cables must meet all local electrical requirements.

Do not use the monitor or SpO_2 sensors during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns. The monitor may affect the MRI image, and the MRI unit may affect the accuracy of the monitor’s measurements.

If multiple instruments are interconnected or if multiple instruments are connected to a patient, the sum of the leakage currents may exceed the limits given in EN/IEC 60601-1-1. Consult your service personnel.

Do not connect this monitor to any equipment or device, other than those specified in this guide.

Sterilization is not recommended for this monitor, accessories or supplies, unless otherwise indicated in the Instructions for Use that accompany the accessories and supplies.

Use only approved accessories with the SureSigns VM monitor. The use of unapproved accessories can diminish monitor performance or safety. Consult the Instructions for Use that accompany the accessories.

Electromagnetic interference may cause disruption of performance. Protect the monitor from sources of intense electromagnetic radiation. This device is designed to provide resistance to electromagnetic interference; however, because of the proliferation of radio-frequency transmitting equipment and other sources of electrical noise (such as cellular phones, mobile two-way radios, and electrical appliances) in the healthcare and home environments, it is possible that high levels of such interference due to close proximity or strength of a source, may result in disruption of performance of this device. Disruption may be evidenced by erratic readings, cessation of operation or other incorrect functioning. If this occurs, the site of use should be surveyed to determine the source of this disruption, and actions taken to eliminate the source. If you need assistance, contact the Philips Customer Care Center or your local Philips Representative.

Consult the Instructions for Use that accompany the accessories

Disposing of the monitor: To avoid contaminating or infecting personnel, the environment or other equipment, make sure you disinfect and decontaminate the monitor appropriately before disposing of it in accordance with your country's laws for equipment containing electrical and electronic parts. For disposal of parts and accessories such as thermometers, where not otherwise specified, follow local regulations regarding disposal of hospital waste.

Before disposing of a SureSigns VM Series patient monitor, delete all patient information. For instructions on deleting patient data, see the *SureSigns VM Series Service Guide.*

This product consists of devices that may contain mercury, which must be recycled or disposed of in accordance with local, state, or federal laws. (Within this system, the backlight lamps in the monitor display contain mercury.)

To protect confidential patient information, do not leave the monitor unattended.

Access to the System Admin Menu is restricted. It is password-protected to ensure that only system administrators, biomedical engineers, or other qualified service personnel can change the system-wide settings on the monitor.

3
Alarms

Alarms alert you to conditions that need immediate attention. Alarms are divided into three levels of severity:

- **High** — Indicates a potentially life-threatening situation; for example, asystole. A high priority alarm requires an immediate response from the clinician.
- **Medium** — Also indicates a physiological condition that requires prompt attention. Medium alarms are most often triggered by an alarm limit violation.
- **Low** — Most low-priority alarms indicate a problem with the monitor that needs to be corrected; for example, an alarm indicating that the recorder is out of paper.

When an alarm event occurs, the monitor issues both a visual and audible alarm.

Note — If your monitor is connected to a VSV, all visual and audible alarms that occur at the bedside monitor are sent to the VSV. For more information, see Chapter 14, "VSV Networked Monitoring."

Visual Alarms

The SureSigns VM Series monitors use the following visual alarm indicators: flashing numeric values, alarm messages, and alarm icons.

Also, in the tabular trend display, a measurement that exceeds alarm limits is enclosed in a box.

Flashing Numeric Values

When a physiological alarm occurs, the text and the background of the pane change colors and start flashing, as described in the following table.

Alarm Priority	Colors
High	Flashing red/white
Medium	Flashing yellow/white
Low	Blue, no flashing

If a measurement exceeds the monitor's measurement range, a question mark (**-?-**) replaces the value in the numeric pane and an **Out of Range** message appears in the message area.

Alarm Messages

Alarm messages appear in the message pane in the bottom left side of the screen. Alarm messages use the same colors as the flashing numeric panes described above. For a complete list of alarm messages and descriptions of each message, see Appendix B, "Alarm Specifications."

High-priority alarm messages pre-empt lower priority alarm messages. After the high-priority alarm has been resolved, the lower priority alarm message appears. If multiple alarms of the same priority occur at the same time, the alarm messages rotate every 1.5 seconds.

Alarm Icons

Alarm icons represent the current alarm status. The following table describes these icons.

Alarm Icon	Description
	The alarm icon with the dashed lines indicates that an alarm has been temporarily silenced, or *paused*. This icon appears when you press the **Alarm Silence** key once to pause all active alarms. It also appears in all numeric panes when you activate the Audio Pause mode to indicate that all alarms have been temporarily silenced for the specified pause period.
	The alarm icon with the solid lines indicates that the alarm(s) have been explicitly turned off by the user and will not sound again until the user explicitly turns them on again. This icon appears when you disable one or more alarms in the parameter menus or the **Alarm Menu**. It also appears in all numeric panes when you activate the Audio Off mode.

For more information, see “Silencing Alarms” on page 3-14.

Note — If your monitor is connected to a VSV, these icons also appear at the VSV to indicate that the alarm has been paused or silenced at the specified bedside.

Audible Alarms

The alarm sound and interval depend on the alarm priority. High priority alarms beep at a faster rate than the medium and low priority alarms and also sound different.

You can change the following audible alarm settings:

- **Alarm volume** — You can increase or decrease the alarm volume. See "Adjusting the Alarm Volume" on page 3-11.
- **Alarm tones** — The SureSigns VM monitor offers two sets of alarm tones. Only authorized personnel can change the alarm tone in the password-protected **System Admin Menu**.
- **Silence alarms** — You can pause alarms or silence them indefinitely. See "Silencing Alarms" on page 3-14.

Warning **Never pause an audible alarm or decrease the alarm volume if this could compromise patient safety.**

Do not rely exclusively on the audible alarm system for patient monitoring. The most reliable method of patient monitoring requires correct operation of the monitor *and* close observation of the patient.

Speaker Malfunction Notification

If the speaker malfunctions, a flashing red/white box with the **AUDIO FAILED** message appears at the top of the screen and the **Speaker Malfunc** message appears in the message pane.

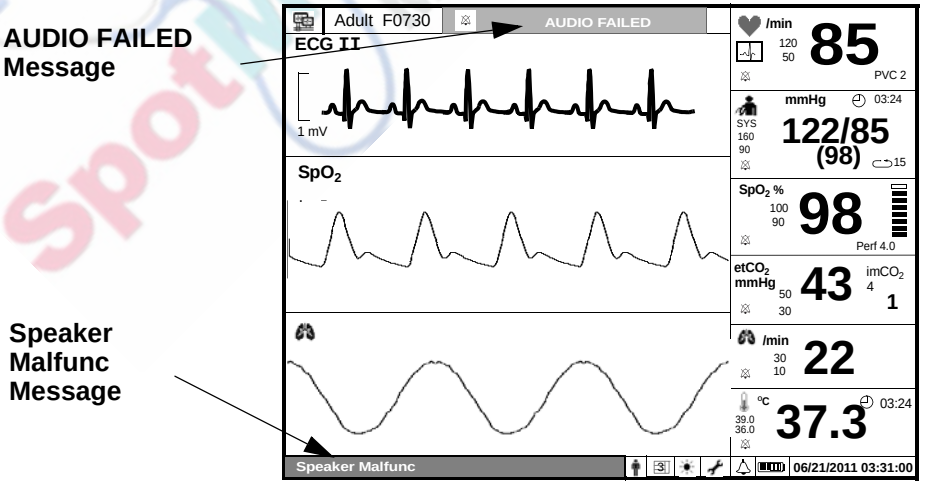
Warning **If the AUDIO FAILED message appears, do not use the monitor and contact your system administrator for repair.**

Note — The speaker malfunction notification is not supported on all versions of VM hardware. If the main board version in your VM monitor is lower than 5, the monitor will not issue the speaker malfunction notification. To determine which main board version is installed in your monitor, see "Changing System Settings" on page 2-26. The main board version is the first segment in the **Hardware ID** field.

Hardware ID: **5 - 0 - A4**

Main board version

For information on manually testing the speaker, see "Testing Alarms" on page 3-17.



Latched and Non-Latched Alarms

When a *non-latched alarm* occurs, the alarm stops when the condition that triggered the alarm ends. For example, if a cable becomes disconnected, the alarm ends when the cable is reconnected. The majority of alarms are non-latched.

On the other hand, a *latched alarm* continues even after the condition that caused the alarm has resolved itself. A V-Tach alarm is an example of a latched alarm. If a V-Tach alarm occurs and the heart rhythm then returns to normal, the alarm will continue to sound to notify the clinician of the V-Tach event.

The following alarms are always latched:

- Asystole
- Ventricular Fibrillation
- Ventricular Tachycardia
- Ventricular Run
- Resp Apnea
- awRR Apnea
- SpO_2 Desat
- NBP Overpressure
- Loss of Monitoring

By default, the alarms listed above are latched and all other alarms are non-latched. However, if your system administrator has enabled the **Latch Physiological Alarms** option, *all* physiological alarms are latched and will continue to sound until you acknowledge the alarm by pressing the **Alarm Silence** key.

Changing Alarm Limits

Warning **Be aware that the monitors in your care area may each have different alarm settings, to suit different patients.**

Always check that the alarm settings are appropriate for your patient before you start monitoring.

When changing alarm limits, do not use extreme alarm limit values, which will render the alarm system useless.

When you start a new patient, the monitor restores all of the alarm settings to their default values.

Note — Default values can be either factory-set default values or values set by your system administrator.

You can change the alarm limits for the current monitoring session by:

- Changing alarm limits for an individual parameter, using the parameter's numeric pane menu. See "Changing Individual Alarm Limits" on page 3-8.
- Opening the **Alarm Menu** to change some or all of the alarm limits in one place. See "Changing Alarm Limits in the Alarm Menu" on page 3-9.

The new alarm limits remain in effect for the current monitoring session. The alarm limits are reset to default values when you start a new patient or change the patient type.

Note — During the time that you are changing alarm limits, the alarm system will continue to operate normally.

Changing Individual Alarm Limits

To change the alarm limits or disable the alarm for one parameter:

Step	
1	Rotate the wheel until the desired numeric pane is highlighted.
2	Press the wheel to display the current values for the selected parameter.
3	Rotate the wheel until the high or low alarm limit is highlighted.
4	Press the wheel and then rotate it to increase or decrease the value.
5	Press the wheel to save the selected option.
6	To disable the audible alarm for the selected parameter, rotate the wheel until the alarm icon is highlighted.  Alarm Disabled Icon Press the wheel until an X appears across the alarm icon. After an alarm has been disabled, an alarm icon appears in the numeric pane where the alarm was disabled. **Note —** *If your system administrator has changed the alarm disable setting in the password-protected* **System Admin Menu**, *you cannot disable audible alarms (the option is unavailable).*
7	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing Alarm Limits in the Alarm Menu

Note — The **Alarm Menu** is unavailable in SpotCheck mode.

To change alarm limits or disable alarms for one or more parameters:

Step	
1	 Alarms button Rotate the wheel until the **Alarms** button on the bottom of the screen is highlighted.
2	Press the wheel. The **Alarm Menu** appears. Current alarm settings are displayed.
3	Rotate the wheel until a high or low alarm limit is highlighted.
4	Press the wheel and then rotate it to increase or decrease the value.
5	Press the wheel to save the selected option.
6	To disable an alarm, rotate the wheel until the alarm icon is highlighted.  Alarm Disabled Icon Press the wheel until an X appears across the alarm icon. After an alarm has been disabled, an alarm icon appears in the numeric pane where the alarm was disabled. **Note —** *If your system administrator has changed the alarm disable setting in the password-protected* **System Admin Menu**, *you cannot disable audible alarms (the option is unavailable).*
7	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Setting System Alarm Options

Use the **Alarm Menu** to:

- Change alarm limit settings (see “Changing Alarm Limits in the Alarm Menu” on page 3-9)
- Enable print on alarm
- Show or hide alarm limits
- Adjust the alarm volume
- Set custom alarm limits
- Restore default alarm settings

Enabling Print on Alarm

You can configure the monitor to automatically generate a printout when a physiological alarm occurs. For more information, see “Enabling Print on Alarm” on page 12-5.

Showing or Hiding Current Alarm Limits

Current high and low alarm limits are displayed in each numeric pane by default.

To change the alarm limit display:

Step	
1	Open the **Alarm Menu** and rotate the wheel until the **Display Alarm Limits** check box is highlighted.

2	Press the wheel until the desired setting appears. ✓ = Alarm limits display in all numeric panes No ✓ = Alarm limits do not display in the numeric panes
3	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Adjusting the Alarm Volume

Note — Your system administrator can set a minimum alarm volume, which prevents you from setting the volume below the specified level.

To increase or decrease the alarm volume:

Step	
1	Open the **Alarm Menu** and rotate the wheel until the **Alarm Tone Volume** option is highlighted.
2	Press the wheel and then rotate the wheel to increase or decrease the volume.
3	Press the wheel again. The new alarm volume takes effect immediately.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Setting Customized Alarm Limits

The Auto Set Alarm Limits feature allows you to quickly set alarm limits that are based on an individual patient's vital signs measurements. After you take an initial set of

measurements, the monitor takes these values and applies a calculated offset to each value to generate new upper and lower alarm limits.

Note — If the calculated offset value exceeds the alarm limit range, the system does not change the upper and lower alarm limits.

The formulas used for calculating the Auto Set Alarm Limits and the alarm limit ranges are listed in Appendix B, “Alarm Specifications.”

To enable Auto Set Alarm Limits:

Step	
1	To establish a baseline, take an initial set of vital signs measurements on the patient.
2	Open the **Alarm Menu** and rotate the wheel until the **Auto Set Alarm Limits** button is highlighted.
3	Press the wheel. A message asks if you are sure you want to change the alarm limits.
4	Rotate the wheel until the **Yes** button is selected and press the wheel. The monitor creates new high and low alarm limits based on the existing measurements. **Note —** *The alarm limits change for existing measurements only; the alarm limits do not change if a parameter was not measured.*
5	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Restoring Default Alarm Settings

Note — Default alarm settings can be either factory-set defaults or defaults set by your system administrator in the password-protected **System Admin Menu**. The default values set by your system administrator override the factory defaults.

Alarm settings include the alarm limits, as well as the enable/disable alarm settings.

To restore the default alarm settings:

Step	
1	Open the **Alarm Menu** and rotate the wheel until the **Restore Default Alarm Settings** button is highlighted.
2	Press the wheel. A message asks if you are sure you want to restore the default settings.
3	Rotate the wheel until the **Yes** button is selected and press the wheel. The monitor restores all alarm settings to the default values.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Note — The system automatically restores default values when you start a new patient or change the patient type.

Factory default values are listed in Appendix B, “Alarm Specifications.”

Silencing Alarms

Alarm Silence key

The following table lists the methods that you can use to silence audible alarms using the **Alarm Silence** key on the front panel of the monitor.

Note — Measurements can be either continuous or aperiodic. Continuous measurements include SpO_2, Heart Rate derived from ECG or SpO_2, CO_2, Impedance Respiration, Invasive Blood Pressure, and continuous Temperature. Aperiodic measurements include NBP, Heart Rate derived from NBP, and Predictive Temperature. The **Alarm Silence** key responds differently depending on which type of measurement is alarming.

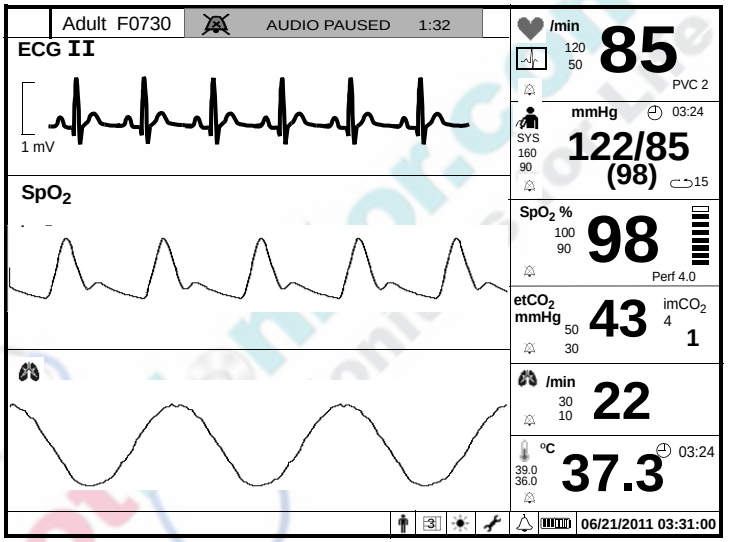
To	Press the	Result
Pause a *continuous* alarm for 60 seconds.	**Alarm Silence** key once.	The active alarm is silenced for 60 seconds. The visual alarm indicators continue to flash.
Silence an *aperiodic* alarm.	**Alarm Silence** key once.	The audible and visual alarm indicators for the active alarm are silenced and cleared.
Pause *all* alarms for a predetermined time interval. (Audio Pause mode)	**Alarm Silence** key twice quickly.	Audible alarms are paused for the Audio Pause period. Visual alarm indicators continue to flash. When the Audio Pause period ends, active alarms sound again.
Silence *all* alarms indefinitely. (Audio Off mode)	**Alarm Silence** key for two seconds.	All alarms are silenced indefinitely. Visual alarm indicators continue to flash.

If your monitor is connected to a VSV, an audible alarm sounds at both the bedside monitor and the VSV. For information on pausing alarms at the VSV, see Chapter 14, “VSV Networked Monitoring.”

Audio Pause Mode

If you press the **Alarm Silence** key two times quickly, the monitor enters Audio Pause mode. All audible alarms are silenced for one of the following pre-defined time intervals: **30**, **60**, **90**, **120**, or **180 seconds**. The time interval is configured by your system administrator in the password-protected **System Admin Menu**.

During Audio Pause mode, a white box with the **AUDIO PAUSED** message appears at the top of the screen and a timer shows the amount of time remaining until the Audio Pause mode ends.



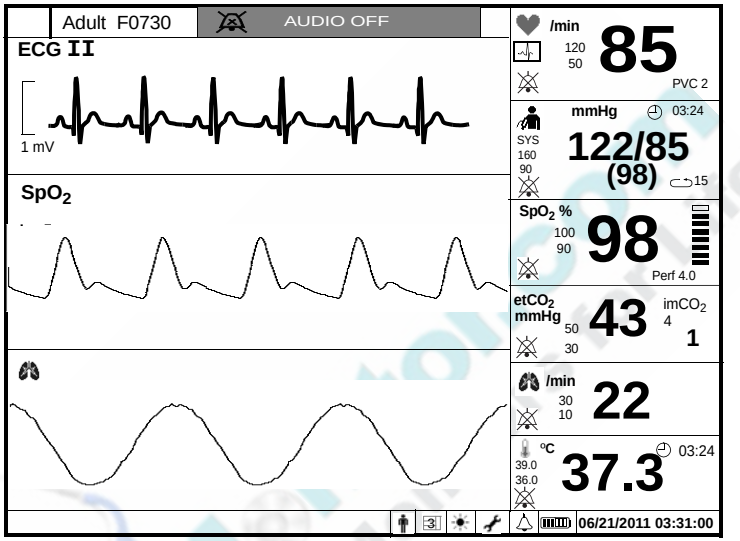
To end Audio Pause mode, press the **Alarm Silence** key.

Audio Off Mode

Note — If your system administrator has disabled the audio off setting in the password-protected **System Admin Menu**, the Audio Off mode is disabled.

If you press and hold the **Alarm Silence** key for 2 seconds, the monitor enters Audio Off mode. All audible alarms are silenced until you press the **Alarm Silence** key again to end the Audio Off mode.

During Audio Off mode, a red box with the **Audio Off** message appears at the top of the screen.



To end Audio Off mode, press the **Alarm Silence** key.

Acknowledging Technical Alarms

When a technical alarm occurs and you press the **Alarm Silence** key once, the monitor responds in one of the following ways:

- For some technical alarms, such as **NBP Artifact** and **SpO2 No Sensor**, the audible alarm is silenced and the error message is cleared.
- For many technical alarms, such as **Low Batt** and **ECG Leads Off**, the audible alarm is silenced, but the alarm message will remain in the message area until the error condition is corrected.

Testing Alarms

To verify that the alarm system is working:

Step	
1	With the monitor turned on, make sure all alarms are enabled (the monitor is not in Audio Pause or Audio Off mode). If you have a VM4, make sure that it is not in SpotCheck mode.
2	Make sure the SpO_2 alarm is enabled (the crossed bell icon does not appear in the SpO_2 numeric pane). If the SpO_2 alarm is disabled, open the **SpO2 Menu** and enable it.
3	Place the SpO_2 sensor on your finger and wait for a value to appear in the SpO_2 numeric pane.
4	Remove the sensor from your finger.
5	Check that the **SpO2 Non-Pulsatile** message appears in the message area and an alarm tone sounds.

Nurse Call System Alarms

A nurse call signal reflects the audio output of the monitor: if the monitor is sounding an alarm, the nurse call system is signaling.

If your monitor is connected to a nurse call system, note the following:

- When an audible alarm is silenced (Audio Pause or Audio Off) at the bedside unit, the nurse call system will not alarm.
- If a user disables one or more alarms (through a specific parameter menu or the **Alarm Menu**) at the bedside unit, these alarms are also disabled on the nurse call system.

Note — Your system administrator can change the alarm priority level for the nurse call signal. For example, if the priority level is set to **High** in the password-protected **System Admin Menu**, only high-priority alarms will sound on the nurse call system. If it is set to **Medium**, both high-priority and medium-priority alarms will sound on the nurse call system.

Alarms Safety Information

Caution

The monitor detects and responds almost immediately to most out-of-limits conditions, except when averaging of the physiological signal is required to reduce unwanted noise signals. Examples of averaging include respiration rates and measurements derived from SpO_2 signals.

Respond immediately to all alarms, including technical alarms. Some technical alarms, such as CO2 Occlusion, indicate that the patient is not currently being monitored because of a system malfunction.

The alarm volume should be loud enough to be heard within a room or through an open door. Set the volume based on the environment and ambient noise levels.

For visual alarms, the side-to-side viewing angle of the display is approximately ± 30 degrees relative to normal viewing.

4
Monitoring SpO_2

The SureSigns VM Series patient monitors use a motion-tolerant signal processing algorithm, which produces four SpO_2 measurements:

- Oxygen saturation of arterial blood (SpO_2) — The percentage of oxygenated hemoglobin in relation to the sum of oxyhemoglobin and deoxyhemoglobin (functional arterial oxygen saturation)
- An SpO_2 (pleth) waveform — A visual indication of a patient's pulse
- A heart rate value — The value is derived from the pleth wave, if SpO_2 is the current heart rate source
- A perfusion indicator — A numeric value for the pulsatile portion of the measured signal caused by arterial pulsation

Selecting an SpO_2 Sensor

When selecting a sensor, consider the patient's weight and activity level, adequacy of perfusion, availability of sensor sites, need for sterility and anticipated duration of monitoring.

You can use two types of SpO_2 sensors:

- **Reusable sensors** can be reused on different patients.
- **Disposable sensors** must not be reused on different patients, however, they can be reused or relocated on the same patient.

For more information on compatible SpO_2 sensors, see Chapter 16, "Accessories List."

Caution **Do not apply the blood pressure cuff to the same extremity as the one to which an SpO_2 sensor is attached because the cuff inflation disrupts SpO_2 monitoring and leads to nuisance alarms.**

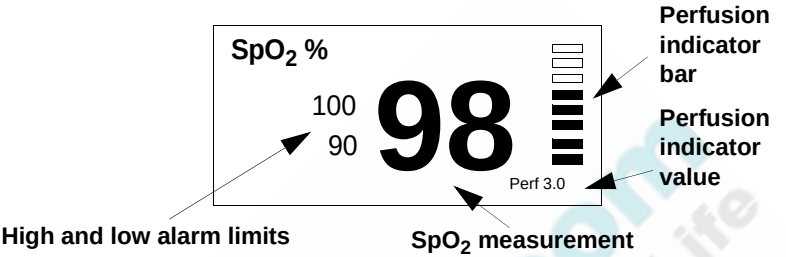
Note — If the SpO_2 measurement is delayed for more than 30 seconds (due to an excessively noisy signal or because the user is trying to measure NBP and SpO_2 on the same limb), the **SpO2 Extd Update** alarm appears and the SpO_2 numeric pane display alternates between the measurement value and a question mark (**-?-**).

Connecting SpO_2 Cables

Connect the sensor cable to the SpO_2 input connector on the side panel, as seen in the illustration. If you are using a disposable sensor, plug the sensor into the adapter cable and plug this cable into the SpO_2 input connector. Plug reusable sensors directly into the input connector.

The SpO_2 Numeric Pane

The following illustration shows the components of the SpO_2 numeric pane.



Changing SpO_2 Settings

Use the **SpO2 Menu** to:

- Change the SpO_2 response mode
- Display or hide the perfusion indicator value
- Change the SpO_2 alarm limits

To open the **SpO2 Menu**:

Step	
1	Rotate the wheel until the SpO_2 numeric pane is highlighted.
2	Press the wheel. The **SpO2 Menu** appears. Current SpO_2 settings are displayed.

Changing the SpO_2 Response Mode

The **SpO2 Response** setting determines how quickly the monitor reports changes in SpO_2 values.

To change the SpO_2 response mode:

Step	
1	Open the **SpO2 Menu** and rotate the wheel until the **SpO2 Response** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **Slow** — Use this setting when motion artifact is an issue. SpO_2 changes are reported more slowly compared to the other modes. • **Normal** — Use this setting for most monitoring situations. • **Fast** — Use this setting for special applications (for example, sleep studies) when you need a fast response. Do not use the **Fast** setting if motion artifact is an issue.
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Displaying the Perfusion Indicator Value

When enabled, the perfusion indicator value appears directly below the perfusion indicator bar. The perfusion indicator value is a numeric value that represents the pulsatile portion of the measured signal caused by the pulsating arterial blood flow.

You can use the perfusion indicator value to determine the quality of the SpO_2 measurement:

- Above **1.0** is optimal.
- Between **0.3** and **1.0** is acceptable.
- Below **0.3** is marginal; reposition the sensor or find a better site.

The perfusion indicator value does not display by default. You must explicitly turn it on to display it in the SpO_2 numeric pane.

To display or hide the perfusion indicator value:

Step	
1	Open the **SpO2 Menu** and rotate the wheel until the **Perfusion Indicator** check box is highlighted.
2	Press the wheel until the desired setting appears. ✓ = Perfusion indicator value will appear in the SpO_2 numeric pane No ✓ = Perfusion indicator value will not appear in the SpO_2 numeric pane
3	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the SpO_2 Alarm Limits

For information on changing the SpO_2 alarm limits, see “Changing Alarm Limits” on page 3-7.

The SpO_2 default alarm limits are:

	Adult	Pediatric	Neonatal
SpO_2 high limit	100%	100%	95%
SpO_2 low limit	90%	90%	85%

Configuring the SpO_2 Waveform

Note — The pleth waveform is normalized to the display area on the screen. The height of the waveform has no relationship to the actual optical signal strength.

Use the **SpO2 Waveform Menu** to:

- Change the speed of the SpO_2 waveform
- Change the position of the SpO_2 waveform

To open the **SpO2 Waveform Menu**:

Step	
1	Rotate the wheel until the SpO_2 waveform is highlighted.
2	Press the wheel. The **SpO2 Waveform Menu** appears. Current SpO_2 waveform settings are displayed.

Changing the Waveform Speed

The **Sweep Speed** setting in the **SpO2 Waveform Menu** determines the speed at which the waveform is drawn across the screen. For information on changing this setting, see "Changing the Waveform Speed" on page 2-15.

The SpO_2 Sweep Speed options are:

- **12.5 mm/s**
- **25.0 mm/s**
- **50.0 mm/s**

Changing the Position of the Waveform

To move the SpO_2 waveform to a different location on the screen, see "Changing the Position of a Waveform" on page 2-13.

Assessing a Suspicious SpO_2 Reading

When pulse rate is very low, or strong arrhythmia is present, the SpO_2/Pleth pulse rate may differ from the heart rate calculated from ECG. However, this does not indicate an inaccurate SpO_2 value.

If you doubt the measured SpO_2 value, use the pleth wave and perfusion indicator to assess the signal quality.

Desaturation Alarm (Desat)

The Desaturation alarm is a high-priority alarm that alerts you to a potentially life-threatening drop in oxygen saturation. The Desat alarm is not configurable; it is based on the current SpO_2 low alarm limit. The Desat alarm limit is fixed at 10 less than the current low limit for adults and pediatric patients and 5 less for neonates.

SpO_2 Safety Information

The SureSigns VM pulse oximeter is calibrated to indicate functional oxygen saturation.

Warning **To minimize risk of damage to the monitor during defibrillation use only approved supplies.**

Never apply an SpO_2 sensor at ambient temperatures above 35°C (95°F) because this can cause severe burns after prolonged application.

Injected dyes, like methylene blue, or intravascular dyshemoglobins (methemoglobin and carboxyhemoglobin) can lead to inaccurate measurements.

Interference can be caused by:

- **High levels of ambient light. To avoid this problem, cover the application site with opaque material.**
- **Electromagnetic interference.**
- **Excessive patient movement and vibration.**

High oxygen levels can predispose a premature infant to retrolental fibroplasia. If this is a consideration, do not set the high SpO_2 alarm limit to 100%. This is equivalent to switching the alarm off. Transcutaneous SpO_2 monitoring is recommended for premature infants receiving supplemental oxygen.

Do not use disposable sensors on patients who have allergic reactions to the adhesive.

Do not use the monitor or SpO_2 sensors during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns. The monitor may affect the MRI image, and the MRI unit may affect the accuracy of the monitor's measurements.

If you are using a VM4 monitor in SpotCheck mode, the SpO2 Non-Pulsatile and SpO2 No Sensor technical alarms are disabled, and these SpO_2 technical alarms do not sound. This allows you to remove the SpO_2 sensor from a patient without sounding alarms.

Caution **Use only specified sensors and cables, otherwise patient injury can result. Before using a sensor, verify that it is compatible with the monitor. For a complete list of compatible accessories, see Chapter 16, "Accessories List."**

Skin irritations or lacerations can occur if the sensor is attached to one location for too long. Inspect the application site every two to three hours to ensure skin quality and correct optical alignment. If the skin quality changes, move the sensor to another site. Change the application site at least every four hours.

Sensors are not sterile and should not be used in a sterile environment.

Do not apply the sensor too tightly as this results in venous pulsation. This can severely obstruct circulation and lead to inaccurate measurements.

Follow the sensor's instructions for use; adhere to all warnings and cautions.

Check that the light emitter and the photo-detector are directly opposite each other. All light from the emitter must pass through the patient's tissue.

Remove colored nail polish from the application site.

Make sure that the sensor is the appropriate size. The sensor should not fall off, nor should it be too tight.

When applying the M1193A or M1193T neonatal sensor, do not overtighten the strap.

When using the M1195A infant finger sensor, select a finger or toe with a diameter of between 7 and 8 mm (0.27" and 0.31").

If a sensor is too loose, it might compromise the optical alignment or fall off. If it is too tight — because the application site is too large or becomes too large due to edema — the excessive pressure may cause venous congestion distal, leading to interstitial edema, hypoxaemia and tissue malnutrition.

Do not use OxiCliq disposable sensors in a high humidity environment, such as in neonatal incubators or in the presence of fluids, which can contaminate sensor and electrical connections causing unreliable or intermittent measurements.

For neonatal patients, place all sensor connectors and adapter cable connectors outside the incubator. The humidity in the incubator can cause inaccurate measurements.

Do not place the sensor on extremities with an arterial catheter or intravascular venous infusion line.

Do not use more than one extension cable (for example, M1941A). Do not use an extension cable with Philips reusable sensors or adapter cables with part numbers ending in -L (which indicates "Long" version).

To avoid electrical interference, position the sensor cable and connector away from power cables.

To dispose of pulse oximeter equipment or components, follow local regulations regarding disposal of hospital waste.

5
Monitoring NBP

The SureSigns VM Series monitors measure Systolic, Diastolic, and Mean Arterial Pressure (MAP) by acquiring pressure pulses through a series of controlled deflation steps of an inflated cuff.

NBP key

The three types of NBP measurements include:

- **Manual measurements** — Press the **NBP** key on the front panel to initiate a single NBP measurement.
- **Interval measurements** — NBP measurements are initiated every *n* minutes, where *n* is the number of minutes between measurements. You change the specified interval in the **Blood Pressure Menu**.
- **STAT measurements** — The monitor takes as many measurements as possible during a 5-minute period, with a pause between each measurement.

NBP Measurement Limitations

You cannot measure NBP on patients with heart rate extremes of less than 40 bpm or greater than 300 bpm, or if the patient is on a heart-lung machine.

NBP measurements may be inaccurate or impossible on patients with the following conditions:

- An irregular arterial pressure pulse
- Cardiac arrhythmias
- Excessive and continuous movement, such as shivering or convulsions
- Rapid blood pressure changes
- Severe shock or hypothermia that reduces blood flow to the peripheries
- Obesity, where a thick layer of fat surrounding a limb dampens the oscillations coming from the artery
- An edematous extremity

Selecting an NBP Cuff

Select an NBP cuff based on the patient's arm size. After wrapping the cuff around the patient's arm, the index line should fall between the two range lines and the arterial marking should be over the patient's brachial artery.

A cuff that is too loose or too tight can cause inaccurate measurements. Also, if the cuff is too loose, it may not deflate properly.

For information on compatible NBP cuffs, see Chapter 16, "Accessories List."

Connecting the Cuff and Hose

Connect the selected cuff to the hose and the hose to the NBP input connector, as seen in the illustration.

Warning **Never connect intra-arterial or intra-venous, or any other Luer connectors, to the NBP hose. This could cause serious injury and death.**

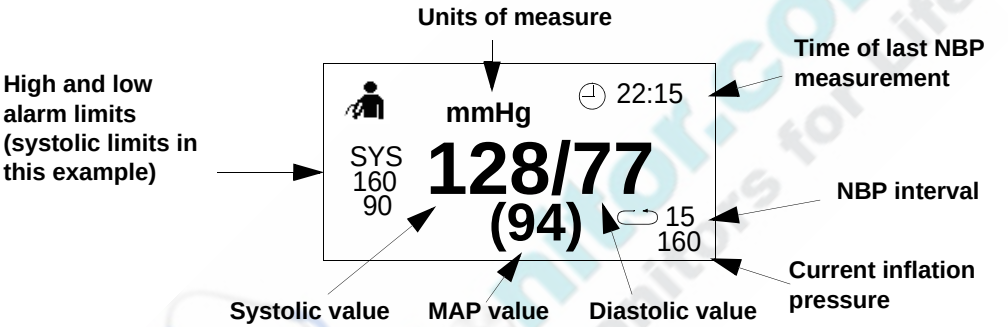
Caution **Do not compress the hose or restrict the pressure.**

The Blood Pressure Numeric Pane

The Blood Pressure numeric pane can be configured to display either NBP or IBP measurement data. This chapter discusses NBP measurements only; Chapter 8, “Monitoring IBP” describes the IBP features and menu options available on some models.

To change the display, see “Enabling the IBP Display” on page 5-13.

The following illustration shows the components of the Blood Pressure numeric pane.



Changing NBP Settings

Use the **Blood Pressure Menu** to:

- Enable or disable the **Auto Print NBP** feature
- Change the NBP alarm limits
- Select whether the Systolic, Diastolic, or MAP alarm limits appear in the Blood Pressure numeric pane
- Select an NBP measurement interval
- Start STAT measurements
- Configure the initial inflation pressure
- Enable or disable the display of IBP values
- Change the units of measurement

To open the **Blood Pressure Menu**:

Step	
1	Rotate the wheel until the Blood Pressure numeric pane is highlighted.
2	Press the wheel. The **Blood Pressure Menu** appears. Current settings are displayed.

Enabling Auto Print NBP

If your monitor has a recorder, you can use the **Auto Print NBP** option to generate a printout each time an NBP measurement is taken. This may be useful when you are taking NBP interval measurements.

To enable auto print:

Step	
1	Open the **Blood Pressure Menu** and rotate the wheel until the **Auto Print NBP** check box is highlighted.
2	Press the wheel until the desired setting appears. ✓ = Auto print is enabled No ✓ = Auto print is disabled
3	Press the Main Screen button on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

For more information on the monitor's printing capabilities, see Chapter 12, "Printing."

Changing the NBP Alarm Limits

For information on changing NBP alarm limits, see “Changing Alarm Limits” on page 3-7.

The NBP default alarm limits are:

	Adult	Pediatric	Neonatal
Systolic			
High limit	160 mmHg (21.3 kPa)	120 mmHg (16.0 kPa)	90 mmHg (12.0 kPa)
Low limit	90 mmHg (12.0 kPa)	70 mmHg (9.3 kPa)	40 mmHg (5.3 kPa)
Diastolic			
High limit	90 mmHg (12.0 kPa)	70 mmHg (9.3 kPa)	60 mmHg (8.0 kPa)
Low limit	50 mmHg (6.7 kPa)	40 mmHg (5.3 kPa)	20 mmHg (2.7 kPa)
MAP			
High limit	110 mmHg (14.7 kPa)	90 mmHg (12.0 kPa)	70 mmHg (9.3 kPa)
Low limit	70 mmHg (9.3 kPa)	50 mmHg (6.7 kPa)	24 mmHg (3.2 kPa)

Changing the Alarm Limits Display

The Blood Pressure numeric pane can only display one set of alarm limits at one time.

To choose the alarm limits to display:

Step	
1	Open the **Blood Pressure Menu** and rotate the wheel until the **Limit Display** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **SYS** • **DIA** • **MAP**
3	Press the wheel to save the selected option. The Blood Pressure numeric pane displays the selected alarm limits.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Starting NBP Interval Measurements

You can configure SureSigns VM Series patient monitors to measure a patient's blood pressure at pre-defined time intervals. An interval is measured from the start of one NBP measurement (when the pump starts) to the start of the next measurement.

Note — You cannot take NBP Interval measurements in SpotCheck mode.

If your system administrator enables the **Align Interval to Clock** option, the NBP interval measurements are aligned with the time of day. This means that if you set the interval to 10 minutes, and you press the **NBP** key at 10:17 to start the interval, the monitor will record the first measurement at 10:17. The next NBP measurement will begin at 10:20, then 10:30, 10:40, and so on.

If the **Align Interval to Clock** option is disabled, the measurements in the previous example will occur at 10:17, 10:27, 10:37, and so on.

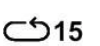
If time synchronization is enabled and the monitor time changes by more than 30 seconds, the monitor starts a new NBP measurement.

Note — If you start a new patient or change the patient type, the interval reverts to the default value. The factory default value is **Off**.

Your system administrator can change the default interval period from **Off** to a specific time interval. When you start a new patient or change the patient type, the Auto Interval defaults to the specified time interval. This default value can only be changed by qualified service personnel in the password-protected **System Admin Menu**.

To start NBP interval measurements:

Step	
1	Open the **Blood Pressure Menu** and rotate the wheel until the **Auto Interval** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: **Off**, **1**, **2**, **3**, **5**, **10**, **15**, **30**, **60**, **90**, or **120 minutes**.
3	Press the wheel to save the selected option.

4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel. The **Press**  message flashes in the Blood Pressure numeric pane.
5	Press the **NBP** key on the front panel to begin the first interval measurement.  The Interval icon and the current interval value appear in the lower right corner of the Blood Pressure numeric pane.

Starting NBP STAT Measurements

In STAT mode, the monitor takes as many measurements as possible during a 5-minute period, with a pause between each measurement. At the end of the 5-minute period, the interval setting returns to Off or to the **Default NBP Interval** value, if your system administrator set a default interval value.

Note — The pause time between NBP measurements varies with each patient, but the pressure in the cuff is reduced to less than 15 mmHg for adults and 5 mmHg for neonates.

Note — You cannot take STAT measurements in SpotCheck mode.

To start STAT measurements:

Step	
1	Open the **Blood Pressure Menu** and rotate the wheel until the **STAT** menu item is highlighted.
2	Press the wheel.  STAT measurements begin immediately. The word STAT and the Interval icon appear in the lower right corner of the Blood Pressure numeric pane.

To stop STAT measurements, press the **NBP** key on the front panel or select the **Stop** option from the **STAT** menu item.

Configuring the Initial Inflation Pressure

The **Initial Inflation Pressure** setting specifies the maximum amount that the cuff will inflate for the first NBP measurement. When you take subsequent NBP measurements on the same patient, the monitor adjusts the inflation value based on the patient's Systolic measurement.

The factory default value for Initial Inflation Pressure is based on the patient type:

- Adult — 160 mmHg (21.3 kPa)
- Pediatric — 140 mmHg (18.7 kPa)
- Neonatal — 100 mmHg (13.3 kPa)

As the cuff inflates, the current inflation pressure appears in the lower right corner of the pane (directly below the Auto Interval value). After the measurement is complete, the inflation pressure value disappears from the screen.

To change the initial inflation pressure:

Step	
1	Open the **Blood Pressure Menu** and rotate the wheel until the **Initial Inflation Pressure** menu item is highlighted.
2	Press the wheel and then rotate it to select the desired inflation pressure. The range of values is based on the current patient type.
3	Press the wheel to save the selected value.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

If you start a new patient or change the patient type, the **Initial Inflation Pressure** reverts to the factory default value or the default value set by your system administrator. Default values can be changed in the **System Admin Menu**, which is password-protected.

Note — For safety reasons, the cuff automatically deflates if:

- The measurement time exceeds 120 seconds (90 seconds in Neonatal mode)
- The microprocessor fails
- The overpressure limit is exceeded
- Power is lost

Enabling the IBP Display

Some SureSigns VM Series models can monitor invasive blood pressure (IBP). The **Display IBP** setting in the **Blood Pressure Menu** determines whether or not IBP values are displayed in the Blood Pressure numeric pane.

When **Display IBP** is selected, you can still take NBP measurements. After you take an NBP measurement, the Blood Pressure numeric pane displays the NBP values for 30 seconds and then reverts to the current IBP values.

To enable or disable the IBP display:

Step	
1	Open the **Blood Pressure Menu** and rotate the wheel until the **Display IBP** check box is highlighted.
2	Press the wheel until the desired setting appears. ✓ = IBP display is enabled No ✓ = IBP display is disabled
3	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

After you select the **Display IBP** check box, you select an IBP label, as described in Chapter 8, “Monitoring IBP.”

Changing the NBP Units of Measurement

Note — The selected unit of measurement applies to both NBP and IBP values.

To change the blood pressure units of measurement:

Step	
1	Open the **Blood Pressure Menu** and rotate the wheel until the **Blood Pressure Units** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **mmHg** • **kPa**
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Stopping an NBP Measurement

To stop a manual or interval measurement in progress, press the **NBP** key on the front panel. If the monitor is in interval mode when you press the **NBP** key, the current measurement is stopped, but the next scheduled interval measurement will occur.

Recalculating the NBP Value if the Limb is not at Heart Level

If the limb is not at heart level, adjust the displayed value as follows:

If the limb is	Then
Higher than heart level	For each centimeter higher, add 0.75 mmHg (0.10 kPa) or for each inch higher, add 1.9 mmHg (0.25 kPa)
Lower than heart level	For each centimeter lower, deduct 0.75 mmHg (0.10 kPa) or for each inch lower, deduct 1.9 mmHg (0.25 kPa)

Identifying the NBP Hardware Module

The VM Series patient monitors support two types of NBP hardware modules: Philips and CAS. The steps to monitor NBP are the same whether the monitor contains a Philips or CAS NBP module. However, the high and low limits for physiological NBP alarms, the conditions that cause technical NBP alarms, and the range of Initial Inflation Pressure settings are different for Philips and CAS NBP modules.

Note — This guide contains information about the Philips NBP module. For information about the differences between the Philips and CAS NBP modules, see Appendix C, “NBP Module Comparison.”

You can identify the module type by viewing the monitor’s **Configuration** setting in the **System Menu** window.

To identify which type of NBP module is in your monitor:

Step	
1	Rotate the wheel until the **System** button is highlighted.
2	Press the wheel. The **System Menu** appears.
3	View the **Configuration** setting. The type of NBP module is displayed as one of the following: • **NBP-P** — Philips NBP module • **NBP-C** — CAS NBP module

NBP Safety Information

Caution **Do not reuse disposable NBP cuffs.**

Warning **Select the correct patient category setting for your patient. Do not apply the higher adult inflation, overpressure limits and measurement duration to neonatal patients.**

Do not measure NBP on patients with sickle-cell disease or any condition where skin damage has occurred or is expected.

Continual NBP measurements can cause injury to the patient being monitored. Weigh the advantages of frequent measurement and/or use of STAT mode against the risk of injury. Use clinical judgement to decide whether to perform frequent unattended blood pressure measurements on patients with severe blood clotting disorders because of the risk of hematoma in the limb fitted with the cuff.

In some cases, rapid, prolonged cycling of an NBP cuff has been associated with any or all of the following: ischemia, purpura, or neuropathy. Apply the cuff according to the directions and check the cuff site and cuffed extremity regularly when blood pressure is measured at frequent intervals or over extended periods of time.

Check the patient's limb to assure that circulation is not constricted. Constriction of circulation is indicated by discoloration of the extremity. Check the limb at regular intervals based on the circumstances of the specific situation.

Do not place the cuff on an extremity being used for intravenous infusion or any area where circulation is compromised or has the potential to be compromised.

Do not apply the blood pressure cuff to the same extremity as the one to which an SpO_2 sensor is attached because the cuff inflation disrupts SpO_2 monitoring and leads to nuisance alarms.

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6
Monitoring ECG

An electrocardiogram (ECG) monitors the electrical activity of the heart. The SureSigns VM Series patient monitors process these electrical signals and present an ECG waveform on the screen. The monitor can also:

- Compute and display the heart rate in beats per minute.
- Detect an ECG Leads Off condition and then sound an alarm.
- Detect and filter pacemaker-generated signals.
- Generate a synchronization pulse for use with a defibrillator. The Defib Sync output is available through a connector on the rear panel of the monitor. For more information, see Appendix A, “Defib Sync.”
- Perform arrhythmia analysis (VM6 and VM8 only). For details, see “Changing Heart Rate and Arrhythmia Settings” on page 6-12.
- Calculate respiration rate by sensing changes in transthoracic impedance. For details, see Chapter 10, “Monitoring Respiration.”

About ECG Lead Sets

When choosing an ECG lead set, consider the number of electrodes and the ECG standards — AAMI or IEC — used by your facility. You can use the following types of ECG lead sets with the monitor:

- 3-electrode set with AAMI color coding
- 3-electrode set with IEC color coding
- 5-electrode set with AAMI color coding
- 5-electrode set with IEC color coding

Note — The SureSigns VM4 supports only 3-electrode lead sets; the SureSigns VM6 and VM8 monitors support both 3- and 5-electrode lead sets.

The following table describes AAMI and IEC labels and colors. For ECG electrode placement illustrations, see “Placing the Electrodes” on page 6-3.

AAMI Lead Sets	AAMI Label	AAMI Color
	RA	White
	LA	Black
	LL	Red
	RL	Green
	V	Brown
IEC Lead Sets	**IEC Label**	**IEC Color**
	R	Red
	L	Yellow
	F	Green
	N	Black
	C	White

Important: After selecting a lead set, you must configure the monitor to use the selected lead set (**3 Lead** or **5 Lead**) in the **System Menu**. For information on opening the **System Menu** and changing the lead set, see “Changing System Settings” on page 2-26.

Connecting the ECG Cable

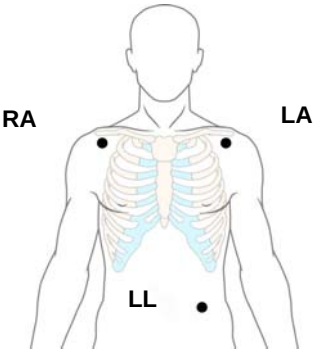
Select the correct size and type of patient cable. If you are using two-part cables, attach the electrode cable to the patient cable. Plug the patient cable into the ECG input connector, as seen in the illustration.

Placing the Electrodes

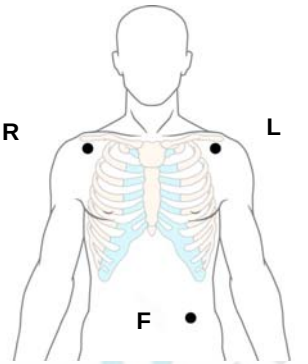
The following figures show the correct placement for the 3-electrode and 5-electrode lead sets. The location of each electrode is the same for AAMI and IEC leads sets, only the color of the leads and the labels are different.

Note — If you enable the **RESP Apnea Alarm**, the timer begins as soon as the leads are connected to the monitor and the patient. For information on configuring Resp Apnea alarms, see Chapter 10, "Monitoring Respiration."

3-Electrode Placement

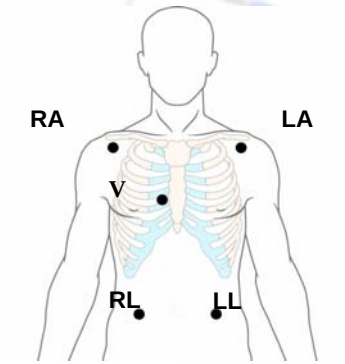


AAMI

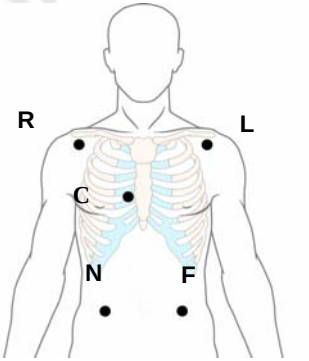


IEC

5-Electrode Placement



AAMI



IEC

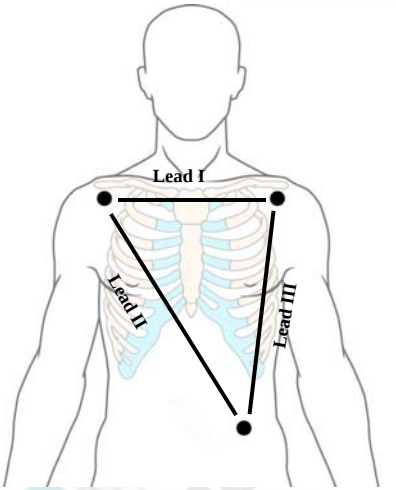
Skin Preparation for Electrode Placement

Before placing electrodes on a patient, follow these steps:

Step	
1	Select sites with intact skin and no impairment of any kind.
2	Clip or shave hair from sites as necessary.
3	Wash sites thoroughly with soap and water, leaving no residue. Do not use ether or pure alcohol because these substances dry the skin and increase resistance.
4	Dry skin thoroughly by rubbing briskly to increase capillary blood flow in the tissues.
5	Use ECG skin preparation (abrasive) paper to remove dead skin cells and to improve the conductivity of the electrode site.

Choosing a Lead

A pair of electrodes forms a *lead*. Each lead provides a different view of the same cardiac activity. In the illustration below, each lead — Lead I, Lead II, and Lead III — records cardiac activity from a different angle.



Lead II is usually appropriate for most monitoring situations. To ensure that the lead you select has adequate amplitude, compare the ECG signal to the 1 mV reference bar in the ECG waveform pane.

On the SureSigns VM6 and VM8 monitors, you can display two ECG waveforms, and therefore, two different leads, at one time.

For arrhythmia analysis, follow the guidelines in “Choosing an ECG Lead for Arrhythmia Monitoring” on page 6-16.

Note — If the ECG signal is invalid, and as a result, cannot be analyzed, the message **Cannot analyze ECG** appears in the ECG waveform pane.

To select a lead:

Step	
1	Rotate the wheel to highlight the ECG waveform whose lead you want to change.
2	Press the wheel. The **ECG Waveform Menu** appears. Current ECG settings are displayed.
3	Rotate the wheel until the **Select Waveform** menu item is highlighted.
4	Press the wheel and then rotate it to select one of the following options: • For a 3-electrode lead set: **ECG I**, **ECG II**, or **ECG III** • For a 5-electrode lead set: **ECG I**, **ECG II**, **ECG III, ECG aVR**, **ECG aVL**, **ECG aVF**, **ECG V**, or **ECG MCL**
5	Press the wheel to save the selected option.
6	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.
7	Repeat steps 1 through 5 to display a second ECG waveform with a different ECG lead. **Note —** *If you choose to display a second ECG waveform, you must select a different lead. You cannot display two ECG waveforms with the same lead.*

Freezing the ECG Waveform

Main Screen Key

To freeze the ECG waveform, press the **Main Screen** key two times quickly. The message **ECG Waveform Frozen** appears in the lower right corner of the ECG waveform pane. If two ECG waveforms are displayed, both are frozen.

To unfreeze the waveform, press the **Main Screen** key once.

To print a frozen waveform, press the **Print** key on the front panel. The primary (topmost) waveform is printed and the text **ECG Waveform Frozen** appears on the printout.

Configuring the ECG Waveform

Use the **ECG Waveform Menu** to:

- Change the speed of the ECG waveform
- Change the size of the ECG waveform
- Enable the ECG filter
- Enable pace detection
- Change the position of one or more ECG waveforms

To open the **ECG Waveform Menu**:

Step	
1	Rotate the wheel until the ECG waveform is highlighted.
2	Press the wheel. The **ECG Waveform Menu** appears. Current ECG settings are displayed.

Changing the Waveform Speed

The **Sweep Speed** setting in the **ECG Waveform Menu** determines the speed at which the waveform is drawn across the screen. For information on changing this setting, see “Changing the Waveform Speed” on page 2-15. The ECG Sweep Speed options are:

- **12.5 mm/s**
- **25.0 mm/s**
- **50.0 mm/s**

Note — Changes to the sweep speed of one ECG waveform apply to all of the displayed ECG waveforms.

Changing the Waveform Size

If the displayed ECG wave is too small or it is clipped, use the **Scale** menu item to adjust the size of the waveform.

To change the display size of the ECG waveform:

Step	
1	Open the **ECG Waveform Menu** and rotate the wheel until the **Scale** menu option is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **Auto** — The monitor selects the best scale for the current waveform. • **2.0 cm/mV** • **1.0 cm/mV** • **0.5 cm/mV** • **0.25 cm/mV**

3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Enabling the ECG Filter

Select the **Filter** check box to reduce interference to the ECG signal. In the operating room, the filter reduces artifacts and interference from electrosurgical units.

Caution **Be aware that in normal measurement conditions, enabling the filter may suppress the QRS complexes too much and thus interfere with ECG analysis.**

To enable ECG filtering:

Step	
1	Open the **ECG Waveform Menu** and rotate the wheel until the **Filter** check box is highlighted.
2	Press the wheel until the desired setting appears. ✓ = ECG filtering is on. No ✓ = ECG filtering is off.
3	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Enabling Pace Detection

You must enable pace detection when monitoring patients with pacemakers. The pace detection feature detects and filters pacemaker-generated signals, so that they are not counted as regular QRS complexes.

When pace detection is enabled, the pace pulses appear as vertical white lines above the ECG waveform. If pace detection is disabled, the text **Pace Detect Off** appears in the ECG Waveform pane. The pace pulse indicators only appear on the primary (top) ECG waveform.

Warning **If pace detection is not enabled when monitoring a patient with a pacemaker, pace pulses could be counted as regular QRS complexes. This might prevent an asystole alarm from sounding.**

Some pace pulses can be difficult to reject. When this happens, the pulses are counted as QRS complexes, and could result in an incorrect HR and failure to detect cardiac arrest or some arrhythmias. Keep pacemaker patients under close observation.

To enable pace detection:

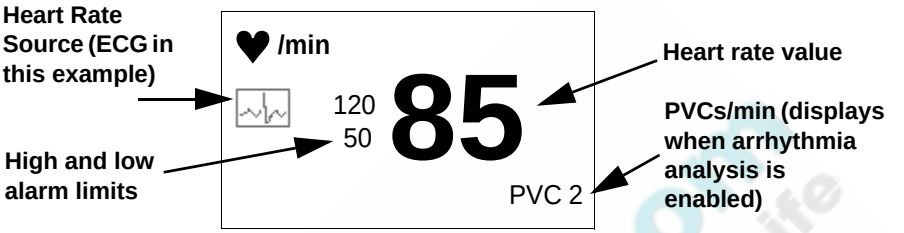
Step	
1	Open the **ECG Waveform Menu** and rotate the wheel until the **Pace Detection** check box is highlighted.
2	Press the wheel until the desired setting appears. ✓ = Pace detection is on. No ✓ = Pace detection is off.
3	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the Position of the Waveform

To move the ECG waveform to a different location on the screen, see “Changing the Position of a Waveform” on page 2-13.

Changing Heart Rate and Arrhythmia Settings

The following illustration shows the components of the Heart Rate numeric pane:



Use the **Heart Rate Menu** to:

- Change the Heart Rate alarm limits
- Change the Heart Rate source
- Change the Heart Rate volume
- Enable Arrhythmia Analysis and change arrhythmia alarm settings

To open the **Heart Rate Menu**:

Step	
1	Rotate the wheel until the Heart Rate numeric pane is highlighted.
2	Press the wheel. The **Heart Rate Menu** appears. Current settings are displayed.

Changing the Heart Rate Alarm Limits

Note — You can set different alarm limits for each Heart Rate source. For more information, see “Changing Alarm Limits” on page 3-7 and “Changing the Heart Rate Source” on page 6-13.

The default alarm limits are:

	Adult	Pediatric	Neonatal
Heart Rate high limit	120 bpm	160 bpm	200 bpm
Heart Rate low limit	50 bpm	75 bpm	100 bpm

Changing the Heart Rate Source

The Heart Rate value can be derived from ECG, SpO_2, or NBP.

You can also select **Auto** as the heart rate source and the monitor will search for an available source in the following order: ECG, SpO_2, and NBP. If a sensor for the current heart rate source is disconnected, the monitor will search for the next available source; if you are not monitoring ECG or SpO_2, but you later connect either the ECG cables or an SpO_2 sensor, the monitor selects the Heart Rate source with the highest priority.

Caution **If you select Auto, the monitor uses the Heart Rate alarm limits for the source that is automatically selected. If your patient requires very specific Heart Rate alarm settings, either do not select Auto for the Heart Rate source or verify that *all* Heart Rate alarm settings are appropriate for your patient.**

If ECG is the selected heart rate source, the lead displayed in the primary (topmost) ECG waveform pane is the lead that will be used as the heart rate source.

If the selected heart rate source is NBP, note the following:

- The heart rate value derived from NBP is an averaged value.
- If you need a continuous heart rate measurement, do not select NBP as the heart rate source. The displayed heart rate value is static, which means that it displays the heart rate value at the time of the last NBP measurement. The value remains in the Heart Rate numeric pane for three minutes. To determine the time at which the heart rate was measured, see the timestamp in the Blood Pressure numeric pane. If you are using a VM4 in SpotCheck mode, the timestamp appears in the Patient Records table.

- The Heart Rate numeric pane does not display a heart rate value when the monitor is placed in NBP STAT mode.

To change the heart rate source:

Step	
1	Open the **Heart Rate Menu** and rotate the wheel until the **HR Source** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **ECG** • **SpO2** • **NBP** • **Auto** **Note —** *Verify that the Heart Rate alarm settings are appropriate for the selected Heart Rate source.*
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Adjusting the Heart Rate Volume

To increase or decrease the heart rate volume:

Step	
1	Open the **Heart Rate Menu** and rotate the wheel until the **HR Tone Volume** menu item is highlighted.
2	Press the wheel and then rotate the wheel to increase or decrease the volume. You can turn the volume Off, if desired.

3	Press the wheel again. The new volume setting takes effect immediately.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Note — The frequency of the heart rate tone varies, depending on which heart rate source is selected: if the source is ECG, the heart rate plays at a fixed frequency; if it is SpO_2, the frequency changes, based on the SpO_2 level; if it is NBP, there is no heart rate tone because the NBP measurement is static.

Arrhythmia Analysis

The SureSigns VM Series patient monitors use the Philips ST/AR arrhythmia algorithm. The algorithm detects changes in the ECG rhythm, while also providing continuous patient surveillance and alarm generation.

Intended Use

The intended use of the ST/AR arrhythmia analysis algorithm is to monitor neonatal, pediatric, or adult patient ECGs for heart rate and ventricular arrhythmias and produce events/alarms for one ECG lead. The arrhythmia analysis algorithm is capable of monitoring both paced and non-paced patients. The ST/AR arrhythmia analysis algorithm is indicated where the clinician decides to monitor cardiac arrhythmia of adult, pediatric, and neonatal patients to gain information for treatment, to monitor adequacy of treatment, or to exclude causes of symptoms.

Overview

The level of arrhythmia analysis depends on the monitor. The SureSigns VM4 monitor provides Asystole monitoring only. The SureSigns VM6 and SureSigns VM8 monitors

can detect an Asystole condition, as well as the following additional arrhythmia conditions:

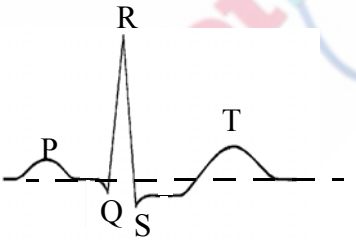
- Ventricular Fibrillation
- Ventricular Tachycardia
- Ventricular Run
- Idioventricular Rhythm
- Pacer non Capture (if **Pace Detection** is enabled)
- Pacer not Pacing (if **Pace Detection** is enabled)
- PVC/min High

If arrhythmia analysis is enabled, the monitor calculates the number of premature ventricular contractions (PVCs) per minute and displays the value in the Heart Rate numeric pane. The PVC value is used as a base measurement for several of the arrhythmia alarms.

Choosing an ECG Lead for Arrhythmia Monitoring

The lead displayed in the primary (topmost) ECG waveform pane is the lead that will be used for arrhythmia analysis.

It is important to select a suitable lead for arrhythmia monitoring. Guidelines for non-paced patients are:



- The QRS should be tall and narrow (recommended amplitude > 0.5 mV).
- The R-wave should be above or below the baseline (but not bi-phasic).
- The T-wave should be smaller than 1/3 R-Wave height.
- The P-wave should be smaller than 1/5 R-wave height.

For paced patients, in addition to the above:

- The pace pulse should be no wider than the normal QRS.

- The QRS complexes should be at least twice the height of pace pulses.
- The pace pulse should be large enough to be detected, with no re-polarization.

To prevent detection of P-waves or baseline noises as QRS complexes, the minimum detection level for QRS complexes is set at 0.15 mV, according to AAMI-EC 13 specifications. Adjusting the ECG wave size on the monitor display (gain adjustment) does not affect the ECG signal which is used for arrhythmia analysis. If the ECG signal is too small, you may get false alarms for pause or asystole.

Enabling Arrhythmia Analysis

If arrhythmia analysis is not enabled in the **Heart Rate Menu**, the SureSigns VM6 and VM8 monitors still detect the following Heart Rate alarms:

- High heart rate
- Low heart rate
- Asystole

The text **Arr Off** appears in the ECG waveform pane when arrhythmia analysis is disabled.

Note — These alarms are also detected on the SureSigns VM4, which does not have arrhythmia analysis.

If arrhythmia analysis is enabled, the VM6 and VM8 monitors detect the alarms listed above, as well as the alarms in the following table. Some of these alarms are based on the ventricular heart rate (**VT Rate**) and the consecutive PVCs counted (**VT Count**). You can change these alarm settings in the **Heart Rate Menu**.

Arrhythmia/ Priority Level	Description	Alarm Message
Ventricular Fibrillation (High priority)	A fibrillatory waveform persists for more than 4 seconds.	**V-Fib**

Arrhythmia/ Priority Level	Description	Alarm Message
Ventricular Tachycardia (High priority)	This alarm is based on the VT Rate and VT Count selected by the user in the **Heart Rate Menu**. If these limits are met, the V-Tach alarm sounds. The default VT Rate is 100 and the default VT Count is 5.	**V-Tach**
Ventricular Run (Medium priority)	The Vent Run alarm is similar to the V-Tach alarm, but is a lower priority arrhythmia alarm. It is based on the specified VT Rate and a VT Count between 3 and the specified VT Count minus 1. For example, if the VT Rate is set at 120 and the VT Count is set at 10, the Vent Run alarm will sound if the patient's VT Rate is 125 and the VT Count is between 3 and 9. If the patient's VT Rate is 125 and the VT Count is 10, the V-Tach alarm will sound.	**Vent Run**
Idioventricular Rhythm (Medium priority)	A dominant rhythm of 14 or more consecutive PVCs.	**Vent Rhythm**
Pacer non Capture (Medium priority)	For paced patients, this alarm occurs when the monitor detects a missed beat with a pace pulse. Specifically, no QRS was detected for 1.75 x the average R-R interval, but a pace pulse was detected.	**Pacer non Capture**

Arrhythmia/ Priority Level	Description	Alarm Message
Pacer not Pacing (Medium priority)	For paced patients, this alarm occurs when the monitor detects a missed beat without a pace pulse. Specifically, no QRS and no pace pulse was detected for 1.75 x the average R-R interval.	**Pacer not Pacing**
PVCs/min High	The total number of PVCs detected in the last 60 seconds has exceeded the specified PVC alarm limit.	**PVCs/min High**

To enable arrhythmia analysis

Step	
1	Open the **Heart Rate Menu** and rotate the wheel until the **Enable Arrhythmia** check box is highlighted.
2	Press the wheel until a checkmark (✓)appears in the **Enable Arrhythmia** check box.
3	Optionally, rotate the wheel until the **VT Rate** or **VT Count** option is highlighted.
4	Press the wheel and rotate it to change the current settings. The choices are: • **VT Rate** — Any value from 100 to 200, in increments of 10. • **VT Count** — Any value from 5 to 15, in increments of 1.
5	Press the wheel to save the selected option.
6	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the PVC Alarm Limits

When arrhythmia analysis is enabled, the PVCs per minute is displayed in the Heart Rate numeric pane. You can change the PVC high alarm limit as described in “Changing Alarm Limits” on page 3-7.

Note — There is no low alarm limit for the PVC parameter.

The default alarm limits are:

	Adult	Pediatric	Neonatal
PVCs high limit	10 PVCs/min	5 PVCs/min	5 PVCs/min

Arrhythmia Relearning

When arrhythmia analysis is enabled and a valid ECG signal is first detected, the arrhythmia algorithm automatically initiates a brief learning period. This is indicated by a question mark (**-?-**) in the Heart Rate numeric pane. During this learning period, the arrhythmia algorithm learns the normal dominant beat for the current patient’s ECG.

Arrhythmia relearning is triggered whenever you:

- Select or clear the **Enable Arrhythmia** check box
- Select or clear the **Pace Detection** check box
- Start a new patient
- Change the primary ECG lead

Arrhythmia relearning also occurs when the monitor cannot analyze ECG for more than 1 minute or it detects an **ECG Leads Off** error.

Warning **If you initiate learning during ventricular rhythm, the ectopics may be incorrectly learned as the normal QRS complex. This may result in missed detection of subsequent events of V-Tach and V-Fib.**

ECG Safety Information

Warning **Use only Philips ECG leads. Other ECG cables and leads can cause improper performance and/or provide inadequate protection during defibrillation.**

Do not use damaged ECG leads.

Do not immerse ECG leads completely in water, solvents, or cleaning solutions because the connectors are not waterproof.

When you are connecting the electrodes or the patient cable, make sure that the connectors never come into contact with other conductive parts, or with earth. In particular, ensure that all of the ECG electrodes are attached to the patient to prevent them from contacting conductive parts or earth.

For pacemaker patients, the monitor can continue to count pacemaker rate during cardiac arrest or some arrhythmias. Do not rely entirely upon the monitor's alarm. Keep pacemaker patients under close surveillance.

Line isolation monitor transients may resemble actual cardiac waveforms and thus inhibit heart rate alarms. Such transients may be minimized by proper electrode and cable placement, as specified in this manual and electrode directions for use.

ECG cables can be damaged when connected to a patient during defibrillation. Check cables that have been connected to a patient during defibrillation for functionality before using them again.

Monitoring with the Pace Detection feature enabled does not normally affect the monitoring of non-pacemaker patients. However, in some instances, if the patient does not have a pacemaker, it can be desirable to turn the detection function Off so that artifacts in the waveform are not mistaken for a pacemaker signal.

Implanted pacemakers, which can adapt to the Minute Volume, can occasionally react on the impedance measurement used by patient monitors for the determination of the Respiration measurement value and execute pacing with the maximum programmed rate. Not monitoring Respiration in this instance can prevent this.

When using Electro-Surgical (ES) equipment, place the ECG electrodes halfway between the ES grounding plate and the ES knife to avoid burning.

Interference from instruments near the patient and Electro-Surgical Unit interference can cause problems with the ECG wave. See the monitor specifications for more information.

When using Electro-Surgical equipment, never place ECG electrodes near the grounding plate of the ES device, as this can cause interference on the ECG signal.

Electromagnetic interference can cause disruption of performance. Protect the monitor from sources of intense electromagnetic radiation. This device has been designed to provide resistance to electromagnetic interference. However, because of the proliferation of radio-frequency transmitting equipment and other sources of electrical noise in the health-care and home environments (such as cellular phones, mobile two-way radios, electrical appliances) it is possible that high levels of such interference due to close proximity or strength of a source can result in disruption of performance of this device. Disruption may be evidenced by erratic readings, cessation of operation or other incorrect functioning. If this occurs, the site of use should be surveyed to determine the source of this disruption, and actions taken to eliminate the source. If assistance is required, contact the Philips' Customer Care Center or your local Philips Representative.

During complete heart block or pacemaker failure (to pace or capture), tall P-waves (greater than 1/5 of the average R-wave height) may be erroneously counted by the arrhythmia algorithm, resulting in missed detection of cardiac arrest.

If you initiate learning during ventricular rhythm, the ectopics may be incorrectly learned as the normal QRS complex. This may result in missed detection of subsequent events of V-Tach and V-Fib.

When arrhythmia monitoring paced patients who exhibit only intrinsic rhythm, the monitor may erroneously count pace pulses as QRS complexes when the algorithm first encounters them, resulting in missed detection of cardiac arrest.

For patients who exhibit intrinsic rhythm only, the risk of missing cardiac arrest may be reduced by monitoring these patients with the low heart rate limit at or slightly above the basic/demand pacemaker rate. A low heart rate alarm alerts you when the patient begins pacing. Proper detection and classification of the paced rhythm can then be determined.

Pacemaker pulses may not be detected when the output of a defibrillator or telemetry unit is plugged into a bedside monitor. This may result in the arrhythmia algorithm's failure to detect pacemaker non-capture or asystole.

When an external pacemaker is being used on a patient, arrhythmia monitoring is severely compromised due to the high energy level in the pacer pulse. This may result in the arrhythmia algorithm's failure to detect pacemaker non-capture or asystole.

Caution **To protect the monitor from damage during defibrillation, for accurate ECG information, and to protect against noise and other interference, use only ECG electrodes and cables specified by Philips.**

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7
Monitoring Temperature

The temperature option installed on your monitor depends on the model:

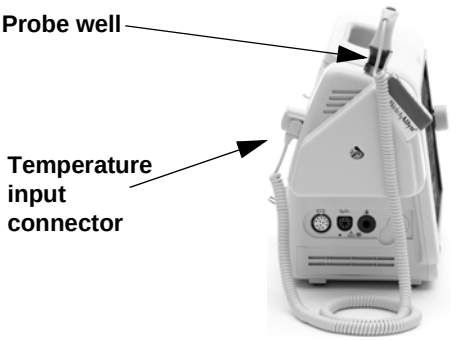
- **SureSigns VM4** — The temperature module is optional on the SureSigns VM4. If you have the temperature option, it includes two measurement modes: predictive and monitored.
- **SureSigns VM6 and VM8** — The temperature module is a standard feature on the SureSigns VM6 and VM8 models and can be used for continuous temperature measurements.

This chapter discusses both types of temperature measurements. Refer to those sections that apply to your monitor.

Note — The temperature probes used with the SureSigns VM4 cannot be used with the SureSigns VM6 and VM8 monitors. For a list of compatible temperature probes, see Chapter 16, “Accessories List.”

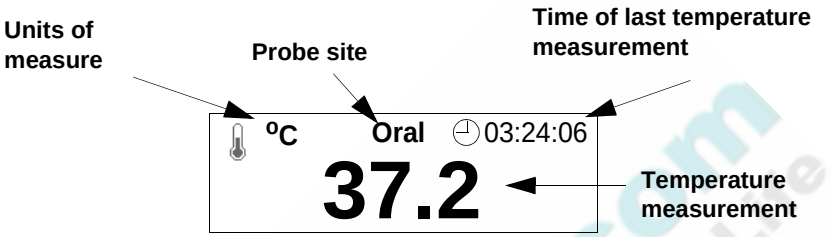
Connecting SureSigns VM4 Temperature Probes

Insert the temperature probe in the probe well. Connect the probe cable to the Temperature input connector on the temperature module, as seen in the illustration.



The SureSigns VM4 Temperature Pane

The following illustration shows the components of the SureSigns VM4 Temperature numeric pane.



Changing Temperature Settings on the SureSigns VM4

Use the **Temperature Menu** to:

- Change the temperature mode
- Change the probe site
- Change the units of measurement

To open the **Temperature Menu**:

Step	
1	Rotate the wheel until the Temperature numeric pane is highlighted.
2	Press the wheel. The **Temperature Menu** appears. Current temperature settings are displayed.

Changing the Temperature Mode on the SureSigns VM4

The SureSigns VM4 has two temperature modes:

- **Predictive mode**. Use Predictive mode for most monitoring situations. In Predictive mode, the monitor measures the patient's temperature for approximately 4 seconds for oral measurements and approximately 16 seconds for axillary and rectal measurements.

  If the probe loses contact with the patient's tissue at any time during the measurement, the Ready icon will reappear and the pane will not display a value until contact has been reestablished.

  If the monitor cannot get a reading after 1 minute, it automatically switches to Monitored mode.

- **Monitored mode**. In Monitored mode, the monitor measures the patient's temperature continuously and displays the temperature in the numeric pane as long as the probe is in contact with the patient.

  Use Monitored mode only when the situation prevents an accurate predictive measurement. The monitor automatically switches to Monitored mode when measurement quality is poor or the probe has been withdrawn from the well and no measurement taken within 60 seconds. Once the probe is returned to the probe well, the monitor cancels Monitored mode and automatically switches back to Predictive mode.

Note — Temperature measurements taken in Monitored mode are not saved to SpotCheck records or the Trend database.

Caution **In Monitored mode, do not exceed the recommended measurement periods of three minutes for oral and rectal measurements and five minutes for axillary measurements.**

To change the temperature mode

Step	
1	Open the **Temperature Menu** and rotate the wheel until the **Mode** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **Monitored** • **Predictive**
3	Press the wheel to save the selected option.  Monitored Mode Icon If you select **Monitored** mode, the Monitored Mode icon appears in the Temperature numeric pane when you withdraw the probe from the well.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Note — In Predictive and Monitored modes, the monitor can sometimes complete a temperature reading even though the quality of the measurement is marginal. When this occurs, the Temperature numeric pane display alternates between the measurement value and a question mark (**-?-**). The measurement is not saved to the patient record.

Changing the Probe Site on the SureSigns VM4

The SureSigns VM4 monitor uses red temperature probes for rectal measurements and blue probes for oral or axillary temperature measurements.

When you connect a red probe to the monitor, the probe site defaults to rectal. When you connect a blue probe, you must select the appropriate probe site to ensure an accurate measurement.

To select the probe site:

Step	
1	Open the **Temperature Menu** and rotate the wheel until the **Blue Probe Site** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **Oral** • **Axillary**
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the Temperature Units of Measurement

To change the temperature units of measurement:

Step	
1	Open the **Temperature Menu** and rotate the wheel until the **Temperature Units** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **°C** (Celsius) • **°F** (Fahrenheit)
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Taking a Temperature Measurement on the SureSigns VM4

To take a temperature measurement on the VM4:

Step	
1	Verify that Predictive mode is selected (the Ⓜ does not appear in the Temperature numeric pane).
2	Remove the temperature probe from the holder.  Ready icon After a few seconds, a chime sounds and the Ready icon appears, indicating that you can now take a temperature measurement. The currently selected probe site (**Oral**, **Axillary**, or **Rectal**) appears in the top of the Temperature pane.
3	If necessary, change the probe site as follows: Put the probe back in the well, open the **Temperature Menu**, select the correct probe site, and remove the temperature probe from the holder again.
4	Place a new cover on the probe.
5	Place the probe in the appropriate probe site (oral, axillary, rectal). An hourglass icon appears in the numeric pane while the monitor is calculating the temperature value and then the final measurement and the time that the measurement occurred appear in the numeric pane. **Note —** *If you are using a VM4 in SpotCheck mode, select the* **Save** *button to save the patient record when all measurements are complete.*
6	Eject the probe cover and dispose of it in accordance with your facility's policies.
7	Replace the probe in the probe well.

Verifying the Temperature Accuracy on the SureSigns VM4

To understand the method for verifying the accuracy of your thermometer, it is important to understand how the thermometer works. Taking repeat temperatures in quick succession on the same patient or comparing the readings to another thermometer will not work for the following reasons:

- The thermometer is a "predictive" thermometer, which means that it uses an algorithm to predict what a patient's temperature would be in 3 – 5 minutes.
- When the thermometer is placed in the patient site, the probe is generally cooler than the patient temperature site and the patient is generally warmer. Heat is then transferred to the probe, causing the patient's body site to be cooled. The body site then takes approximately 20 minutes to return to the original temperature. If you repeat the temperature measurement or use a different thermometer prior to the 20-minute recovery time, the reading will likely be different.
- Different thermometers use different predictive algorithms. These algorithms are based on a sampling of patients' temperatures at the desired quick predict time versus their 3 – 5 minute temperature. Therefore, comparing a SureSigns temperature reading to a reading from a different thermometer is not an effective method for testing accuracy.

If, after taking a predictive measurement on a patient, you want to verify the temperature value, follow these steps:

Step	
1	Place the temperature probe back in the probe well.
2	Open the **Temperature Menu** and rotate the wheel until the **Mode** menu item is highlighted.
3	Press the wheel and then rotate it to select **Monitored**.

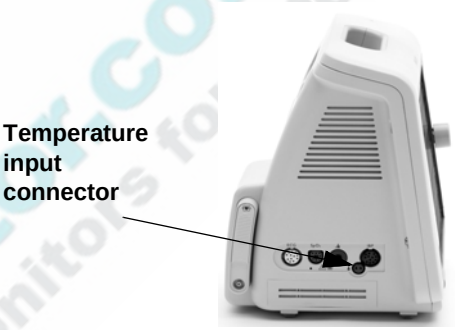
4	Press the wheel to save the selected option and then press the **Main Screen** key on the front panel.  Monitored Mode Icon The Monitored Mode icon appears in the Temperature numeric pane when you withdraw the probe from the well.
5	Pull the temperature probe from the probe well and firmly push the probe into a probe cover.
6	Place the probe in the appropriate site on the patient. **Note —** *The* **Temp Low** *alarm may sound for several seconds while the temperature stabilizes.*
7	Hold the probe in position for the following durations: • 3 minutes for oral and rectal temperatures • 5 minutes for axillary temperatures This is the amount of time it takes for the probe and the patient's body site to come to thermal equilibrium (or the same temperature).
8	Before removing the probe, write down the temperature value. (Monitored temperature values are not saved.)

Connecting SureSigns VM6 or VM8 Temperature Probes

Note — Temperature probes begin measuring ambient temperature as soon as they are connected. To avoid nuisance alarms, you may want to place the probe on the patient before connecting the cable to the monitor.

You cannot measure IBP and Temperature simultaneously.

Connect the probe cable to the Temperature input connector on the side panel, as seen in the illustration. If you are using a disposable probe, plug the probe into the adapter cable (21082B or 21082A) and plug this cable into the Temperature input connector. Plug reusable sensors directly into the input connector.



The SureSigns VM6 and VM8 Temperature Pane

The following illustration shows the components of the SureSigns VM6 and VM8 Temperature numeric pane.

Changing Temperature Settings on the VM6 and VM8

Use the **Temperature Menu** to:

- Change the temperature alarm limits
- Change the units of measurement (see “Changing the Temperature Units of Measurement” on page 7-5)

To open the **Temperature Menu**:

Step	
1	Rotate the wheel until the Temperature numeric pane is highlighted.
2	Press the wheel. The **Temperature Menu** appears. Current temperature settings are displayed.

Changing the Temperature Alarm Limits on the VM6 and VM8

For information on changing the Temperature alarm limits, see “Changing Alarm Limits” on page 3-7.

The Temperature default alarm limits are:

	Adult	Pediatric	Neonatal
Temperature high limit	39°C 102.2 °F	39°C 102.2 °F	39°C 102.2 °F
Temperature low limit	36°C 96.8 °F	36°C 96.8 °F	36°C 96.8 °F

SureSigns VM4 Temperature Safety Information

Warning **After completing a VM4 temperature measurement, remove the probe cover and verify that the temperature probe is firmly seated in the probe well, but do not forcefully insert the probe into the well.**

Biting the oral probe may cause damage to the probe.

When taking an axillary measurement with a VM4, do not take the temperature through the patient's clothing. Direct probe cover-to-skin contact is required.

The use of unapproved probe covers or not using a probe cover can result in the following:

- **Discomfort to the patient**
- **Patient cross-contamination**
- **Erroneous temperature measurements**
- **Damage to the probe**

If the patient temperature is lower than the temperature of the probe, measurement errors may result.

When you take rectal temperature measurements, insert the probe slowly and carefully to avoid tissue damage.

SureSigns VM6 and VM8 Temperature Safety Information

Warning **To minimize risk of damage to the monitor during defibrillation use only approved supplies.**

Use only the specified probes for your monitor.

Do not reuse disposable probes.

The disposable probes are sterile and should be handled accordingly. See the probe package for a Use By date.

Do not use the thermometer if you see any signs of damage to the probe.

Disposal of probe covers must be in compliance with local and facility regulations.

8
Monitoring IBP

The SureSigns VM6 and VM8 monitors can measure the following types of Invasive Blood Pressure (IBP): Arterial Blood Pressure (ABP), Central Venous Pressure (CVP), and Pulmonary Artery Pressure (PAP). The monitor displays IBP measurements as real-time waveforms and numeric values.

In this chapter, the <*pressure*> notation is used to indicate ABP, CVP, or PAP, depending on which pressure is currently active.

Note — IBP is an optional parameter on the SureSigns VM6 and a standard parameter on the SureSigns VM8.

You cannot measure IBP and Temperature simultaneously.

Setting Up

Before you begin an invasive blood pressure measurement you must:

- Connect the transducer and cables
- Select the type of invasive pressure
- Zero the pressure

Note — If you fail to zero the pressure before you begin monitoring, the monitor will not display a value and will display the message **<Pressure> Zero - Required**.

Connecting the Cables

To connect the cables:

Step	
1	Connect the pressure cable to the IBP input connector on the side panel of the monitor, as seen in the illustration. 
2	Prepare the flush solution.
3	Flush the system to exhaust all air from the tubing. Ensure that the transducer and stopcocks are free of air bubbles. **Warning —** ***If air bubbles appear in the tubing system, flush the system with the infusion solution again. Air bubbles can cause an incorrect pressure reading.***
4	Connect the pressure line to the patient catheter.
5	If using an infusion pressure cuff with the pressure line, attach the pressure cuff to the fluid to be infused. Inflate it according to your standard hospital procedure, then start the infusion.
6	Position the transducer so that it is level with the heart, approximately at the level of the midaxillary line.

Selecting a Pressure

When you select ABP, CVP, or PAP in the **Blood Pressure Menu**, the monitor uses the alarm limits for the selected pressure and changes the color of the associated numeric values and waveform.

To select a pressure:

Step	
1	Rotate the wheel until the Blood Pressure numeric pane is highlighted.
2	Press the wheel. The **Blood Pressure Menu** appears. Current settings are displayed.
3	Rotate the wheel until the **Display IBP** check box is highlighted and press the wheel to select the check box.
4	Rotate the wheel until the **Label** menu item is highlighted.
5	Press the wheel and then rotate it to select one of the following options: • **ABP** • **CVP** • **PAP**
6	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Zeroing the Transducer

The monitor requires a valid zero to ensure accurate pressure readings. To do this, you must zero the transducer and the pressure measurement. Zero the transducer in accordance with your hospital policy (at least once per day). Also, perform a zero when:

- Using a new transducer or tubing
- Reconnecting the transducer cable to the monitor
- You think the monitor's pressure readings are incorrect

Before You Begin: If you do not see an ABP, CVP, or PAP waveform pane, see "Changing the Position of a Waveform" on page 2-13.

To zero the pressure measurement:

Step	
1	Turn off the stopcock to the patient.
2	Vent the transducer to atmospheric pressure.
3	Rotate the wheel until the <*pressure*> waveform is highlighted and press the wheel to open the <*Pressure*> **Waveform Menu.**
4	Rotate the wheel until the <*Pressure*> **Zero** button is highlighted.
5	Press the wheel to begin zeroing the pressure. The <*Pressure*> **Waveform Menu** closes. The message **<Pressure> Zero - In Progress** appears in the waveform pane.
6	When you see the message **<Pressure> Zero - Complete**, close the stopcock to atmospheric pressure, and open the stopcock to the patient.

Troubleshooting the Zero

If the Zero is unsuccessful, an error message appears in the waveform pane. The following table lists the error messages and the corrective actions to take.

Message	Corrective Action
Unable to Zero - Noisy Signal	Check the transducer connection and try again.
Unable to Zero - No Transducer	Make sure that the transducer is connected and try again. If this fails, exchange the adapter cable and try again. If this fails, exchange the transducer.
Unable to Zero - Pulsatile Pressure	Make sure that the stopcock is open to atmosphere, not to the patient, and the stopcock is vented. Then try again.

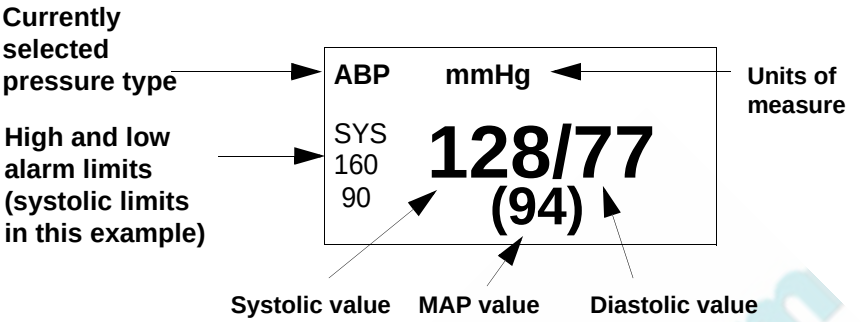
Message	Corrective Action
Unable to Zero - Timed Out	Try selecting the <*Pressure*> Zero button again. If this fails, replace the transducer and adapter cable, and contact your service personnel.
Unable to Zero - Excessive Offset	Make sure that the stopcock is open to atmosphere, not to the patient, and the stopcock is vented. Then try again. If this fails, the hardware may be faulty. Replace the adapter cable and try again. If it fails, replace the transducer and try again. If it still fails, contact your service personnel.

The Blood Pressure Numeric Pane

The Blood Pressure numeric pane can be configured to display either NBP or IBP measurements. This chapter discusses only IBP measurements (ABP, CVP, and PAP); Chapter 5, “Monitoring NBP,” describes NBP features and menu options.

Note — If you select the **Display IBP** check box in the **Blood Pressure Menu,** the Blood Pressure numeric pane displays IBP values. However, you can still take NBP measurements. When you take an NBP measurement, it is temporarily displayed in the Blood Pressure numeric pane. After 30 seconds, the display reverts to current IBP values.

The following illustration is an example of an ABP numeric pane. The CVP and PAP panes are similar.



Changing IBP Settings

Use the **Blood Pressure Menu** to:

- Select an invasive pressure type (see “Selecting a Pressure” on page 8-2)
- Change alarm limits
- Select whether the Systolic, Diastolic, or MAP alarm limits appear in the numeric pane
- Change the units of measurement

To open the **Blood Pressure Menu:**

Step	
1	Rotate the wheel until the Blood Pressure numeric pane is highlighted.
2	Press the wheel. The **Blood Pressure Menu** appears. Current settings are displayed.

Changing the IBP Alarm Limits

For information on changing IBP alarm limits, see “Changing Alarm Limits” on page 3-7.

The default alarm limits are:

	Adult		Pediatric		Neonatal	
	High	**Low**	**High**	**Low**	**High**	**Low**
ABP Systolic	160 mmHg (21.3 kPa)	90 mmHg (12.0 kPa)	120 mmHg (16.0 kPa)	70 mmHg (9.3 kPa)	90 mmHg (12.0 kPa)	55 mmHg (7.3 kPa)
ABP Diastolic	90 mmHg (12.0 kPa)	50 mmHg (6.7 kPa)	70 mmHg (9.3 kPa)	40 mmHg (5.3 kPa)	60 mmHg (8.0 kPa)	20 mmHg (2.7 kPa)
ABP MAP	110 mmHg (14.7 kPa)	70 mmHg (9.3 kPa)	90 mmHg (12.0 kPa)	50 mmHg (6.7 kPa)	70 mmHg (9.3 kPa)	35 mmHg (4.7 kPa)
CVP Mean	10 mmHg (1.3 kPa)	0 mmHg (0.0 kPa)	4 mmHg (0.5 kPa)	0 mmHg (0.0 kPa)	4 mmHg (0.5 kPa)	0 mmHg (0.0 kPa)
PAP Systolic	35 mmHg (4.7 kPa)	10 mmHg (1.3 kPa)	60 mmHg (8.0 kPa)	24 mmHg (3.2 kPa)	60 mmHg (8.0 kPa)	24 mmHg (3.2 kPa)
PAP Diastolic	16 mmHg (2.1 kPa)	0 mmHg (0.0 kPa)	4 mmHg (0.5 kPa)	-4 mmHg (-0.5 kPa)	4 mmHg (0.5 kPa)	-4 mmHg (-0.5 kPa)
PAP MAP	20 mmHg (2.7 kPa)	0 mmHg (0.0 kPa)	26 mmHg (3.5 kPa)	12 mmHg (1.6 kPa)	26 mmHg (3.5 kPa)	12 mmHg (1.6 kPa)

Selecting the IBP Alarm Limits Display

The Blood Pressure numeric pane can display only one set of IBP alarm limits at one time.

Note — CVP uses Mean alarm limits only, so the **Limit Display** option is unavailable if CVP is the selected pressure.

To choose the IBP alarm limits to display:

Step	
1	Select a pressure, as described in “Selecting a Pressure” on page 8-2. The alarm limits change, based on the selected pressure.
2	Rotate the wheel until the **Limit Display** menu item (below the IBP alarm limits) is highlighted.
3	Press the wheel and then rotate it to select one of the following options: • **SYS** • **DIA** • **MAP**
4	Press the wheel to save the selected option. The Blood Pressure numeric pane displays the selected alarm limits.
5	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the IBP Units of Measurement

Note — The selected unit of measurement applies to both IBP and NBP values.

To change the blood pressure units of measurement:

Step	
1	Open the **Blood Pressure Menu** and rotate the wheel until the **Blood Pressure Units** menu item is highlighted.

2	Press the wheel and then rotate it to select one of the following options: • **mmHg** • **kPa**
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Configuring the Waveform

Use the **<*Pressure*> Waveform Menu** to:

- Change the speed of the waveform
- Change the size of the waveform
- Zero the pressure (see “Zeroing the Transducer” on page 8-3)
- Change the position of the <*pressure*> waveform

To open the <*Pressure*> **Waveform Menu**:

Step	
1	Rotate the wheel until the <*pressure*> waveform is highlighted. If you do not see an ABP, CVP, or PAP waveform pane, see “Changing the Position of a Waveform” on page 2-13.
2	Press the wheel. The <*Pressure*> **Waveform Menu** appears. Current waveform settings are displayed.

Changing the Waveform Speed

The Sweep Speed setting determines the speed at which the waveform is drawn across the screen. For information on changing this setting, see “Changing the Waveform Speed” on page 2-15.

The Sweep Speed options are:

- **3.125 mm/s**
- **6.25 mm/s**
- **12.5 mm/s**
- **25.0 mm/s**

Changing the Waveform Size

If the displayed wave is too small or it is clipped, use the **Scale** menu option to adjust the size.

Note — If you select **Auto** from the **Scale** menu option, the scale adjusts as the patient’s pressure changes.The scale adjustment occurs at the end of the current wave.

To change the size of the waveform:

Step	
1	Open the <*Pressure*> **Waveform Menu** and rotate the wheel until the **Scale** menu option is highlighted.

2	Press the wheel and then rotate it to select one of the following options: • For **ABP**: – **Auto** – **–10 - 20 mmHg (–1.3 - 2.7 kPa)** – **0 - 50 mmHg (0.0 - 6.7 kPa)** – **0 - 100 mmHg (0.0 - 13.3 kPa)** – **0 - 150 mmHg (0.0 - 20.0 kPa)** – **0 - 200 mmHg (0.0 - 26.7 kPa)** – **0 - 250 mmHg (0.0 - 33.3 kPa)** – **0 - 300 mmHg (0.0 - 40.0 kPa)** • For **CVP** and **PAP:** – **Auto** – **–20 - 0 mmHg (–2.7 - 0 kPa)** – **–10 - 0 mmHg (–1.3 - 0 kPa)** – **–5 - 0 mmHg (–0.7 - 0 kPa)** – **0 - 10 mmHg (0 - 1.3 kPa)** – **0 - 20 mmHg (0 - 2.7 kPa)** – **0 - 30 mmHg (0 - 4.0 kPa)** – **0 - 40 mmHg (0 - 5.3 kPa)** – **0 - 50 mmHg (0 - 6.7 kPa)**
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the Position of the Waveform

To move the <*pressure*> waveform to a different location on the screen, see “Changing the Position of a Waveform” on page 2-13.

IBP Safety Information

The monitor and its accessories must be tested by qualified service personnel at regular intervals to ensure that performance has not been degraded by aging or environmental conditions. Periodic performance verification tests can be performed, as described in the *SureSigns VM Series Service Guide.*

Warning **It is the responsibility of the user to ensure that a zero procedure is done at the recommended intervals, otherwise there will be no recent, valid zero value for the instrument to use.**

Do not reuse disposable pressure transducers.

Use only approved accessories to ensure accurate IBP measurements.

Invasive pressure alarms are turned off while the transducer is zeroing. The alarms turn back on after the zeroing is finished.

To avoid degrading isolation and electrical safety of the monitor, make sure that all leads and transducers connected to the monitor do not come in contact with grounded surfaces or other electrical cables or components.

Caution **During defibrillation, the pressure values may be temporarily interrupted or distorted. After defibrillation, monitoring will continue as before.**

If liquid (other than the solution used to infuse the pressure line and transducer) is spilled on the equipment or accessories, particularly if there is a chance that this liquid could get inside the transducer, contact your Biomed or other service person. Your biomed can verify the monitor's performance and safety.

The disposable pressure domes are sterile and should be handled accordingly. See the package for a Use By date.

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9
Monitoring Carbon Dioxide

The SureSigns VM8 patient monitor uses the Microstream® sidestream etCO_2 method to measure carbon dioxide (CO_2). The sidestream measurement method samples the respiratory gas with a constant flow from the patient's airway and analyzes it with a remote CO_2 sensor built into the monitor.

Note — The CO_2 measurement is only available on the SureSigns VM8 patient monitor.

Use the CO_2 measurement to monitor a patient's respiratory and ventilation status. The CO_2 measurement produces:

- A CO_2 waveform.
- An end tidal (**etCO2**) value: the CO_2 value measured at the end of the expiration phase.
- An inspired minimum CO_2 (**imCO2**) value: the smallest value measured during inspiration.
- An airway respiration rate (**awRR**): the number of breaths per minute, calculated from the CO_2 waveform.
- Apnea alarms based on the awRR.

Selecting CO_2 Accessories

In intubated patients, a sample of the respiratory gas is drawn from the patient's breathing circuit through an airway adapter and a gas sampling tube. In non-intubated patients, the gas sample is drawn through a nasal or an oral-nasal cannula.

When selecting CO_2 accessories, consider the following:

- The type of patient (adult, pediatric, or neonatal)
- Whether the patient is receiving supplemental oxygen
- The probability that the patient will switch between oral and nasal breathing
- The condition of the patient (ventilated or not ventilated)
- If the patient is ventilated, whether ventilation is humidified or non-humidified
- Whether the CO_2 monitoring will be short-term or long-term

Note — For best results, for short term monitoring, use FilterLine Sets (with orange connectors). For long term monitoring, use FilterLine Set H (with yellow connectors).

All accessories are for single patient use.

Intubated Patients: Use a Microstream FilterLine® set for non-humidified ventilation on intubated patients. Use the FilterLine H set for humidified ventilation.

Non-Intubated Patients: Use a Smart CapnoLine®, which is a combined oral-nasal FilterLine. Use the Smart CapnoLine O_2, a combined oral-nasal O_2/CO_2 FilterLine, to measure CO_2 and for patients who are receiving supplemental oxygen.

Note — When using an Infant/Neonatal VitaLine™ H Set with an incubator, position one Nafion® humidity filter inside the incubator and the second Nafion humidity filter outside the incubator, close to the incubator tubing access door.

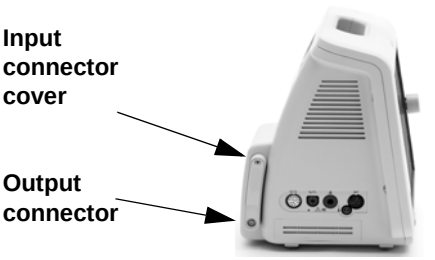
Long FilterLines and long Smart CapnoLines add an additional 3 seconds to the overall response time.

For additional information on CO_2 accessories, see Chapter 16, "Accessories List."

Connecting the Sampling Line

Note — The **awRR Apnea Alarm** timer begins when the sampling line is connected to the monitor.

To connect the sampling line:

Step	
1	Attach the Luer connector to the CO_2 input connector on the side of the monitor by pushing the socket cover down and screwing the connector into place. Screw the sampling line connector clockwise into the CO_2 input connector until it can no longer be turned, to ensure that it is connected securely to the monitor. This will ensure that gas does not leak from the connection point and that measurement accuracy is not compromised.  **Input connector cover** **Output connector**

2	Check that the sampling line is not kinked.
3	If you see a **CO2 Purging** alarm message, this indicates that the sampling line is being purged to remove an occlusion in the line or airway adapter. When the occlusion is removed, the message is cleared.

Note — When the system performs an auto zero, the following occurs:

- The **CO2 Auto Zero** message appears in the message area.
- A question mark (**-?-**) appears in the CO_2 numeric pane to indicate that CO_2 measurements are suspended during the Auto Zero period.
- The CO_2 waveform goes to zero to indicate that CO_2 measurements are suspended during the Auto Zero period.

Disconnect the FilterLine Set during suctioning and nebulizing therapies.

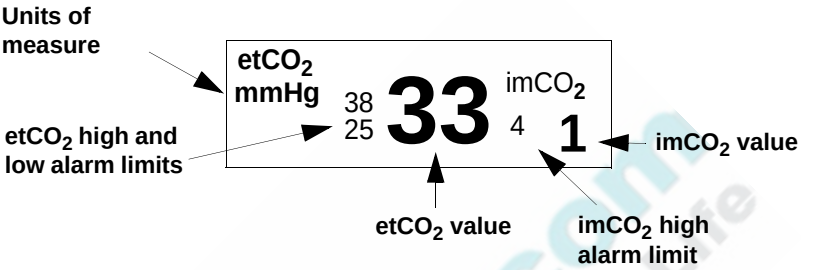
CO_2 values for non-intubated patients using Microstream accessories will always tend to be lower than for intubated patients. If values appear extremely low, check whether the patient is breathing through the mouth or whether one nostril is blocked.

Removing Exhaust Gases from the System

When monitoring CO_2 on patients who are receiving or have recently received anesthetics, use an exhaust tube to remove the sample gas to a scavenging system that meets the requirements of your facility. Attach it to the SureSigns VM8 CO_2 output connector. This avoids exposing medical staff to the anesthetics.

The CO_2 Numeric Pane

The following illustration shows the components of the CO_2 numeric pane.



Changing CO_2 Settings

Use the **CO2 Menu** to:

- Change the $etCO_2$ and $imCO_2$ alarm limits
- Change the CO_2 measurement time
- Adjust humidity settings
- Change the units of measure

To open the **CO2 Menu**:

Step	
1	Rotate the wheel until the CO_2 numeric pane is highlighted.
2	Press the wheel. The **CO2 Menu** appears. The current CO_2 settings are displayed.

Changing the $etCO_2$ and $imCO_2$ Alarm Limits

For information on changing the $etCO_2$ and $imCO_2$ alarm limits, see “Changing Alarm Limits” on page 3-7.

The $etCO_2$ and $imCO_2$ default alarm limits are:

	Adult	Pediatric	Neonatal
$etCO_2$			
High limit	50 mmHg (6.7 kPa)	50 mmHg (6.7 kPa)	50 mmHg (6.7 kPa)
Low limit	30 mmHg (4.0 kPa)	30 mmHg (4.0 kPa)	30 mmHg (4.0 kPa)
$imCO_2$			
High limit	4 mmHg (0.5 kPa)	4 mmHg (0.5 kPa)	4 mmHg (0.5 kPa)
Low limit	NA	NA	NA

Note — There is no low alarm limit for $imCO_2$.

Changing the CO_2 Measurement Time

The **Max Hold** setting specifies whether the CO_2 numeric pane displays the highest CO_2 value measured within the configured time period (**Max Hold** set to 10, 20, or 30 seconds) or the breath-to-breath value (**Max Hold** set to **Off**).

To change the CO_2 measurement time:

Step	
1	Open the **CO2 Menu** and rotate the wheel until the **Max Hold** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **Off** — The CO_2 pane displays the highest CO_2 value from one breath to the next. • **10 seconds** — The CO_2 pane displays the highest CO_2 value measured during a 10-second period. • **20 seconds** — The CO_2 pane displays the highest CO_2 value measured during a 20-second period. • **30 seconds** — The CO_2 pane displays the highest CO_2 value measured during a 30-second period.
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Setting the Humidity Correction

The **Humidity Correction** setting corrects the measured $etCO_2$ value to account for humidity in a patient's breath.

To change the humidity correction value:

Step	
1	Open the **CO2 Menu** and rotate the wheel until the **Humidity Correction** menu item is highlighted.
2	Press the wheel and select one of the following options: • **BTPS** — Body Temperature Pressure Saturated • **STPD** — Standard Temperature Pressure Dry **Note —** *Use BTPS in most situations. The $etCO_2$ readings in BTPS mode are about 6 to 12% lower than the readings in STPD mode.*
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the CO_2 Units of Measurement

To change the CO_2 units of measurement:

Step	
1	Open the **CO2 Menu** and rotate the wheel until the **CO2 Pressure Units** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **mmHg** • **kPa**
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Testing the $etCO_2$ Alarms

To test the $etCO_2$ alarms:

Step	
1	Assuming you are healthy, measure your $etCO_2$ rate by connecting the sampling line as instructed in “Connecting the Sampling Line” on page 9-3.
2	After you receive a value, set the upper alarm limit below that value. For example, if your $etCO_2$ is 45 mmHg, set the upper limit to 40 mmHg.
3	Measure your $etCO_2$ again. An alarm condition should occur.

Configuring the CO_2 Waveform

Use the **CO2 Waveform Menu** to:

- Change the speed of the CO_2 waveform
- Configure awRR apnea alarms
- Change the position of the CO_2 waveform

To open the **CO2 Waveform Menu**:

Step	
1	Rotate the wheel until the CO_2 waveform is highlighted.
2	Press the wheel. The **CO2 Waveform Menu** appears. Current CO_2 settings are displayed.

Changing the Waveform Speed

The **Sweep Speed** setting in the **CO2 Waveform Menu** determines the speed at which the waveform is drawn across the screen. For information on changing this setting, see “Changing the Waveform Speed” on page 2-15.

The CO_2 Sweep Speed options are:

- **3.125 mm/s**
- **6.25 mm/s**
- **12.5 mm/s**
- **25.0 mm/s**

Configuring awRR Apnea Alarms

The **awRR Apnea Alarm** time defines the length of time between breaths before generating the **awRR Apnea** alarm. For example, if the **awRR Apnea Alarm** time is set to **20 seconds**, and the monitor does not detect a breath for more than 20 seconds, the monitor sounds an **awRR Apnea** alarm.

The default time is **20 seconds**.

Caution **If you are monitoring both ECG and CO_2, apnea alarms are always derived from the airway respiration rate (awRR), not the impedance respiration rate (RR). Apnea settings in the CO2 Waveform Menu override apnea settings in the Respiration Waveform Menu.**

To configure awRR apnea alarms:

Step	
1	Open the **CO2 Waveform Menu** and rotate the wheel until the **awRR Apnea Alarm** menu item is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **10 seconds** • **15 seconds** • **20 seconds** • **25 seconds** • **30 seconds** • **35 seconds** • **40 seconds**
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Changing the Position of the Waveform

To move the CO_2 waveform to a different location on the screen, see “Changing the Position of a Waveform” on page 2-13.

Identifying the CO_2 Hardware Module

The VM8 supports two types of CO_2 hardware modules: Oridion CO_2 module and Oridion CO_2 with SARA.

To identify which type of CO_2 module is in your monitor:

Step	
1	Rotate the wheel until the **System** button is highlighted.
2	Press the wheel. The **System Menu** appears.
3	View the **Configuration** setting. The type of CO_2 module is displayed as one of the following: • **CO2-O** — Oridion CO_2 module • **CO2-S** — Oridion CO_2 module with SARA

The steps to monitor CO_2 are the same for both CO_2 modules. However, the CO2-S module has a higher upper alarm limit range for etCO_2 alarms and includes the SARA algorithm.

SARA Algorithm

The CO2-S module includes the Smart Alarm for Respiratory Analysis (SARA) alarm management technology. The SARA technology reduces the occurrence of nuisance **Resp Rate Low** alarms, while accurately reflecting the patient’s condition and preserving clinically significant alarm vigilance.

Note — This guide contains information about both CO_2 modules. Differences in alarm limits are noted in "Factory Default Alarm Limits and Alarm Ranges" on page B-11.

CO_2 Safety Information

Warning **To minimize risk of damage to the monitor during defibrillation use only approved supplies.**

etCO_2 measurement accuracy may decrease temporarily while performing electro-surgery or defibrillation. This does not affect patient or equipment safety.

The etCO_2 readings do not always correlate closely with paCO_2 values, especially in patients with pulmonary disease, pulmonary embolism or inappropriate ventilation.

Do not measure CO_2 in the presence of pharmaceuticals in aerosols.

Explosion hazard: The Sidestream measurement should not be used in the presence of flammable anesthetics such as:

- **Flammable anesthetic mixture with air**
- **Flammable anesthetic mixture with Oxygen or Nitrous Oxide**

CO_2 values for non-intubated patients using Microstream accessories always tend to be lower than for intubated patients. If values appear extremely low, check whether the patient is breathing through the mouth or whether one nostril is blocked.

Leakages in the breathing system or sampling system may cause the displayed etCO_2 values to be too low. Always connect all components securely and check for leaks according to standard clinical procedures. Displacement of the nasal or combined nasal oral cannulas can cause lower than actual etCO_2 readings.

When using a sampling line for intubated patients with a closed suction system, do not place the airway adapter between the suction catheter and endotracheal tube. This is to ensure that the airway adapter does not interfere with the functioning of the suction catheter.

When using the CO_2 measurement on patients who are receiving or who have recently received anesthetics, connect the outlet to a scavenging system or to the anesthesia machine/ventilator to prevent exposure of medical staff to anesthetics.

Use only approved accessories to ensure accurate CO_2 measurements.

Do not reuse, clean, or sterilize Microstream CO_2 accessories as they are intended for single patient, one-time use.

The sampling line may ignite in the presence of O_2 when directly exposed to laser, ESU devices, or high heat. When performing head and neck procedures involving laser, electrosurgical devices or high heat, use with caution to prevent flammability of the sampling line or surrounding surgical drapes.

Do not cut or remove any part of the sampling line. Cutting the sampling line could lead to inaccurate readings.

If too much moisture enters the sampling line (from ambient humidity or breathing of unusually humid air), the message CO2 Purging appears in the message area. The CO2 Purging message is cleared if the sampling line is successfully purged.

Apnea alarming is suspended while the system performs an auto zero. The apnea detection timer restarts after the auto zero is complete.

Caution **To protect the monitor from inadvertently drawing in liquids, do not connect the sampling line until you are ready to begin monitoring. The CO_2 pump turns on, and stays on, when the sampling line is connected.**

To ensure CO_2 measurement accuracy, ask your system administrator to calibrate the CO_2 module as soon as the CO2 Calibration Needed technical alarm appears.

The spring-loaded door over the CO2 input connector protects the CO_2 module from dust and fluid, which can cause blockages. If the spring-loaded door is broken, contact your system administrator.

The following conditions may cause inaccurate CO_2 measurements:

- **Incorrect application of CO_2 accessories**
- **Using the monitor in environments that do not meet recommended temperature, humidity, and altitude environments**
- **Some patient conditions, such as abnormal pulmonary perfusion or pulmonary disease.**

If you change the patient type during CO_2 measurements, it will take up to 30 seconds for the system to reinitialize.

Dispose of sampling lines according to standard operating procedures or local regulations for the disposal of contaminated medical waste.

Before use, carefully read the *Instructions for Use* that are shipped with the CO_2 accessories.

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10
Monitoring Respiration

Respiration can be measured using one of the following methods:

- **ECG**. The respiration rate (RR) is calculated by sensing changes in the trans-thoracic impedance between the right arm and left leg of the ECG cable set. Impedance respiration monitoring is available on the VM4, VM6, and VM8 monitors.
- **CO_2**. If your monitor is configured for CO_2, you can measure a patient's airway respiration rate (awRR). The awRR value is calculated by directly measuring air movement in and out of the patient's airway. Airway respiration monitoring is available on the VM8 monitor with optional CO_2.

The VM4, VM6 and VM8 monitors also support apnea alarms, which are based on either the impedance respiration rate (RR) or the airway respiration rate (awRR). An apnea alarm occurs when no breath has been detected for longer than the user-specified time period.

If you are monitoring both ECG and CO_2 on a VM8:

- Respiration derived from CO_2 always overrides impedance respiration measurements.
- Apnea alarms are always derived from the CO_2 airway respiration rate.

For more information on monitoring CO_2 and configuring awRR apnea alarms, see Chapter 9, "Monitoring Carbon Dioxide."

Warning **Do not use an OR ECG cable set when monitoring respiration. Respiration can only be monitored with an ICU ECG cable set. This is because of the higher internal impedance of the OR cable set, which is required during electro-surgery.**

Note — Correct patient skin preparation techniques for electrode placement are important for respiration measurements. Follow the instructions in “Placing the Electrodes” on page 6-3.

Optimizing ECG Lead Placement for Respiration Measurements

When measuring respiration through ECG, you may need to reposition the two electrodes between which impedance will be measured to avoid the following:

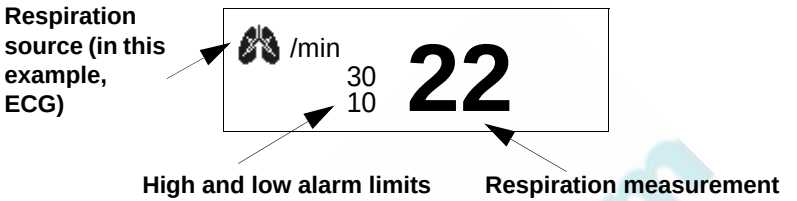
- Cardiac Overlay: Cardiac overlay, which occurs when the respiration electrodes pick up impedance changes caused by the rhythmic blood flow, can affect the Resp waveform. Correct electrode placement can help to reduce cardiac overlay: avoid the liver area and the ventricles of the heart in the line between the respiratory electrodes. This is particularly important for neonates.
- Lateral Chest Expansion: Some patients, especially neonates, expand their chests laterally. In these cases, it is best to place the two respiratory electrodes in the right midaxillary and left lateral chest areas at the patient's maximum point of breathing movement to optimize the respiratory wave.

- Abdominal Breathing: Some patients with restricted chest movement breathe mainly abdominally. In these cases, you may need to place the left leg electrode on the left abdomen at the point of maximum abdominal expansion to optimize the respiratory wave.

Note — Repositioning ECG electrodes to achieve better respiration measurements can result in changes in the ECG waveform and may influence arrhythmia interpretation.

The Respiration Numeric Pane

The following illustration shows the components of the Respiration numeric pane.



The icon in the upper left corner of the pane shows the current respiration source. If CO_2 is the source, **awRR** is displayed; if ECG is the source, the lung-shaped icon is displayed.

Changing Respiration Settings

Use the **Respiration Menu** to:

- Change the Respiration alarm limits
- Disable Impedance Respiration

You can also select the **Apnea Settings** button in the **Respiration Menu** to quickly jump to the apnea configuration settings as follows:

- If you are monitoring CO_2, and you select the **Apnea Settings** button, the **CO2 Waveform Menu** opens.
- If you are monitoring impedance respiration, but not monitoring CO_2, and you select the **Apnea Settings** button, the **Respiration Waveform Menu** opens.

For more information on awRR apnea alarms, see Chapter 9, “Monitoring Carbon Dioxide.”

To open the **Respiration Menu**:

Step	
1	Rotate the wheel until the Respiration numeric pane is highlighted.
2	Press the wheel. The **Respiration Menu** appears. Current Respiration settings are displayed.

Changing the Respiration Alarm Limits

For information on changing the Respiration alarm limits, see “Changing Alarm Limits” on page 3-7.

The Respiration default alarm limits are:

	Adult	Pediatric	Neonatal
Respiration high limit	30 rpm	30 rpm	100 rpm
Respiration low limit	8 rpm	8 rpm	30 rpm

Disabling Impedance Respiration

Impedance respiration is enabled by default. If you do not want to monitor impedance respiration on your patient, you can disable it in the **Respiration Menu**.

Note — If you disable impedance respiration, all associated settings in the **Respiration Waveform Menu**, including apnea alarms, are also disabled.

To disable impedance respiration:

Step	
1	Open the **Respiration Menu** and rotate the wheel until the **Impedance Resp** menu item is highlighted.
2	Press the wheel and then rotate it to select **Disable**.
3	Press the wheel to disable Impedance Respiration.  A red X appears across the lung icon in the Respiration numeric pane and the Respiration waveform pane (if displayed).
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Configuring the Respiration Waveform

Use the **Respiration Waveform Menu** to:

- Change the speed of the Respiration waveform
- Change the scale of the Respiration waveform
- Configure the Respiration apnea settings
- Change the position of the Respiration waveform

To open the **Respiration Waveform Menu**:

Step	
1	Rotate the wheel until the Respiration waveform is highlighted.
2	Press the wheel. The **Respiration Waveform Menu** appears. Current Respiration waveform settings are displayed.

Changing the Waveform Speed

The **Sweep Speed** setting in the **Respiration Waveform Menu** determines the speed at which the waveform is drawn across the screen. For information on changing this setting, see “Changing the Waveform Speed” on page 2-15. The Respiration Sweep Speed options are:

- **6.25 mm/s**
- **12.5 mm/s**
- **25.0 mm/s**
- **50.0 mm/s**

Changing the Waveform Size

If the displayed Respiration waveform is too small or it is clipped, use the **Scale** menu item to adjust the size of the waveform.

Warning **If RESP apnea alarms are on, check the apnea threshold after you change the Scale setting. For more information on setting the apnea threshold, see "Configuring Respiration Apnea Settings" on page 10-8.**

To change the display size of the Respiration waveform:

Step	
1	Open the **Respiration Waveform Menu** and rotate the wheel until the **Scale** menu option is highlighted.
2	Press the wheel and then rotate it to select one of the following options: • **x4** • **x2** • **x1** • **x1/2**
3	Press the wheel to save the selected option.
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Configuring Respiration Apnea Settings

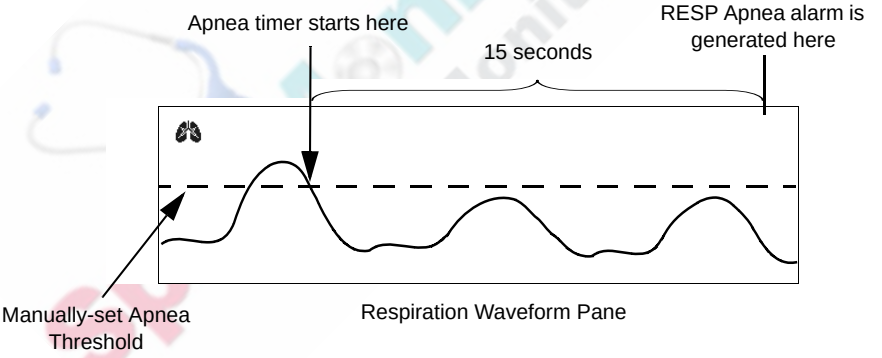
Caution **If you are monitoring CO_2, apnea alarms are derived from the airway respiration rate (awRR), not the impedance respiration rate (RR). For more information on configuring awRR apnea alarms, see "Configuring awRR Apnea Alarms" on page 9-11.**

To configure RESP apnea alarms, you must:

1. Select an apnea time.
2. Manually adjust the apnea threshold in the Respiration waveform pane.

The RESP Apnea alarm sounds if no breaths break the threshold for the selected apnea time.

For example, assume you set the apnea time to 15 seconds. In the following illustration, the apnea timer begins when the downstroke of the wave crosses the apnea threshold line. If the wave continues to fall below the threshold for more than 15 seconds, the **Resp Apnea** alarm sounds.



When adjusting the threshold line for apnea detection, consider the patient's current breathing pattern, and that the breathing pattern may change over time. For example, some patients may not breathe as deeply at night, so their breath may no longer cross the threshold line, resulting in false apnea alarms. It may be necessary to adjust the Apnea Threshold in these situations.

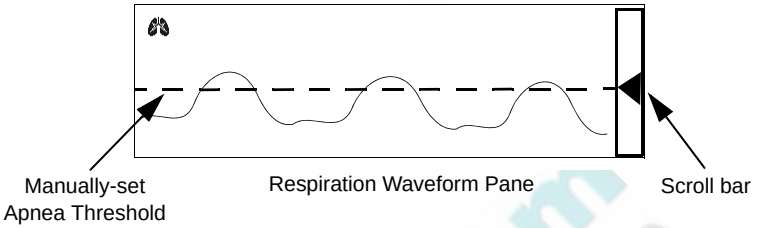
Warning **If you set the threshold too low, the monitor is more likely to detect artifact and miss an apnea event. If you set the threshold too high, you may get false apnea alarms.**

The position of the Apnea Threshold does not change when you start a new patient. The threshold stays where it was last placed. You must always check the placement of the threshold when you start a new patient.

Caution **It is possible for the monitor to detect respiration and still sound the Resp Apnea alarm if the Apnea Threshold is set too high. Check the Scale setting of the respiration waveform and the placement of the Apnea Threshold.**

To configure respiration apnea settings

Step	
1	Attach the ECG electrodes.
2	Display the Respiration waveform pane and verify that you have a viable respiration waveform: • If the waveform is too small or too large, adjust the **Scale** setting in the **Respiration Waveform Menu**. • If necessary, adjust the placement of the ECG electrodes.
3	Open the **Respiration Waveform Menu** and rotate the wheel until the **RESP Apnea Alarm** menu item is highlighted.
4	Press the wheel and then rotate it to select one of the following options: • **Off** • **10 seconds** • **15 seconds** • **20 seconds** • **25 seconds** • **30 seconds** • **35 seconds** • **40 seconds** **Note —** *If you select* **Off**, *the message* **Apnea Off** *appears in the Respiration numeric pane, and the* **Apnea Threshold** *option is unavailable*
5	Press the wheel to save the selected option.
6	Rotate the wheel until the **Apnea Threshold** menu item is highlighted.

7	Press the wheel. The **Respiration Waveform Menu** closes and a scrollbar appears in the Respiration waveform pane.  **Warning —** ***To minimize the possibility of a missed apnea event, check the position of the apnea threshold periodically.***
8	Rotate the wheel to move the threshold line up or down.
9	Press the wheel to set the threshold.

Changing the Position of the Waveform

To move the waveform to a different location on the screen, see “Changing the Position of a Waveform” on page 2-13.

Respiration Safety Information

Warning **The VM Series patient monitors are not apnea monitors. The respiration measurement does not recognize obstructive and mixed apneas — it only indicates when a user-defined time has elapsed since the last detected breath.**

The safety and effectiveness of the respiration measurement method in the detection of apnea, particularly in premature and infant patients, has not been established.

Implantable pacemakers, which are minute ventilation rate adaptive, can occasionally interact with the impedance measurement of cardiac monitors causing the pacemakers to pace at their maximum.

Keep patients under close surveillance when monitoring respiration. Respiration signals are sensitive to interference from radiated electromagnetic signals. Although unlikely, radiated electromagnetic signals from sources external to the patient and monitor might cause inaccurate respiration readings.

11
Viewing Trend Data

Trend data is useful for assessing a patient's progress over a period of time. The trend database can store and display the following information for a single patient:

- Time at which each set of measurements was recorded
- Heart Rate value and Heart Rate source
- NBP
- IBP (ABP, CVP, PAP)
- SpO_2
- Temperature
- Respiration rate
- $etCO_2$
- $imCO_2$
- All physiological alarm events

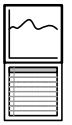
A *trend record* is defined as the data that is captured from the time you start a new patient until you either shut down the monitor or start a different patient. When you start a new patient, all current patient data is cleared from the trend database.

Continuous measurements (for example, SpO_2 and Respiration) are captured and stored in the trend database every 15 seconds; aperiodic measurements (for example, NBP) are recorded at the time that the measurement is started.

The trend database can store up to 96 hours of trending data. After 96 hours, the oldest data is deleted to make room for newer data.

Selecting a Trend Display Format

You can display trend data in a graphical or tabular format. To choose a display format:

Step	
1	 Trend key Press the **Trend** key on the front panel. The Tabular trend format appears the first time you power up the system. If you change the trend format, the system remembers the format you selected and will display that format the next time you open the trend display.
2	 Graphical display Tabular display To change the display format, rotate the wheel until the **Trend Display** button is highlighted and press the wheel. Select either the Graphical or Tabular option and press the wheel. **Note —** *You may not see any trend data when you first open either the Tabular or Graphical trend display. To configure the display, see "Changing the Graphical Display Settings" on page 11-5 or "Changing the Tabular Display Settings" on page 11-9.*

By default, the trend layout remains active for 3 minutes if no other user interaction occurs. To close the trend display, press the **Trend** key again or press the **Main Screen** key.

Note — Your system administrator can change the default trend display timeout period in the password-protected **System Admin Menu**.

When the trend display is enabled, the ECG waveform is still visible at the top of the screen and all numeric panes are visible on the right side of the screen. You can still access the menus and change settings in all of the numeric panes, with one exception: you cannot change the ECG lead when the trend display is enabled.

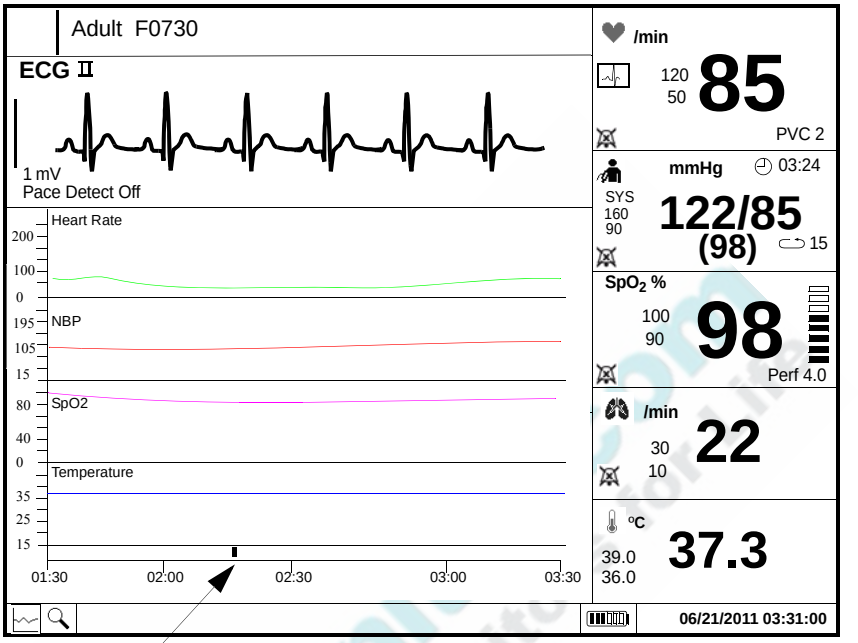
If a high-priority alarm occurs while the trend display is open, the monitor will close the trend display and return to the layout that was active before the trend display was opened.

Note — If the clock on your monitor is synchronized with the clock on the network server or clock on the VSV, and the time on the monitor is adjusted, a blue line appears in the graphical and tabular trend displays.

If the clock is adjusted by more than 30 seconds, the monitor displays a **Date / Time Adjusted** alarm message in addition to the blue line in the trend displays. If the monitor is taking automatic NBP interval measurements, the monitor starts a new NBP measurement.

About the Graphical Trend Display

The following illustration shows the Graphical trend display.



Parameter values are plotted vertically along the y-axis of the graphical display and a time range appears along the horizontal x-axis. The most recent measurements appear on the right side of the graph and the data scrolls to the left, so the oldest data appears on the far left side of the graph.

To increase or decrease the resolution of the graph, you can change the **Time Scale** setting in the **Graphical Trend Menu**. The available range is from 15 minutes to 24 hours. For more information, see “Changing the Resolution of the Graphical Trend Data” on page 11-6.

If a physiological alarm occurs, a small dot appears along the bottom of the graph. The color of the dot indicates the alarm priority: red for high priority, yellow for medium priority, and blue for a low priority alarm.

NBP measurements are displayed as vertical lines. The top of the line represents the Systolic reading, the blank area in the middle of the vertical line represents the MAP reading, and the bottom of the line represents the Diastolic reading.

Changing the Graphical Display Settings

Use the **Graphical Trend Menu** to:

- Change the parameters that appear in the display
- Increase or decrease the resolution of the data that appears in the graphical display

To open the **Graphical Trend Menu**:

Step	
1	 Trend Menu button — With the Graphical display open, rotate the wheel until the **Trend Menu** button is highlighted.
2	Press the wheel. The **Graphical Trend Menu** appears. The first time you open the Graphical trend display**,** a message prompts you to select the parameters you want to display. See the next section, "Selecting Parameters for the Graphical Display."

Selecting Parameters for the Graphical Display

The monitor can display up to four parameters in the Graphical trend display. If you try to select more than four, a message informs you that you have exceeded the maximum number of parameters.

If a parameter is selected in the **Graphical Trend Menu**, but that parameter is not currently being measured, the graph for that parameter appears in the Graphical trend display with no data points. If a parameter is not selected in the **Graphical Trend Menu**, the graph for that parameter is removed from the Graphical trend display.

To change the displayed parameters:

Step	
1	Open the **Graphical Trend Menu**. All available parameters (based on your monitor's configuration) are listed.
2	Rotate the wheel to highlight a parameter and then press the wheel to select or deselect the check box next to the parameter: ✓ = The parameter will appear in the trend display. No ✓ = The parameter will not appear in the trend display.
3	Rotate the wheel until the **Return** button is selected and press the wheel to return to the graphical display. The parameter selections are saved and will reappear the next time you open the Graphical trend display.

Note — You cannot change the order in which the parameters are displayed.

Changing the Resolution of the Graphical Trend Data

Changing the **Time Scale** setting in the **Graphical Trend Menu** will increase or decrease the resolution of the data in the graphical display. If you anticipate a situation where measurement data will change rapidly, choose a higher resolution time scale.

To change the time scale:

Step	
1	Open the **Graphical Trend Menu** and rotate the wheel until the **Time Scale** option is highlighted.

2	Press the wheel and then rotate it to select one of the following options: **15 minutes**, **30 minutes**, **1 hour**, **2 hours**, **4 hours**, **8 hours**, **16 hours**, **24 hours**.
3	Press the wheel to save the selected option.
4	Rotate the wheel until the **Return** button is selected and press the wheel to return to the graphical display.

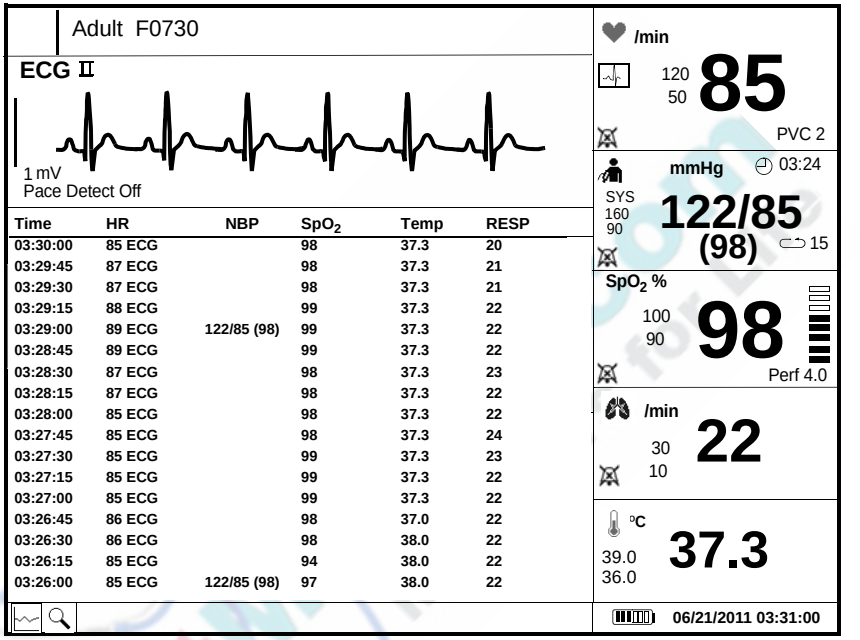
Scrolling Through the Graphical Display

To scroll through the graphical display:

Step	
1	Rotate the wheel to highlight the scroll bar at the bottom of the graphical display.
2	Press the wheel to enable the scroll bar.
3	Rotate the wheel counter-clockwise to view older data or clockwise to view the newest trend data.
4	Press the wheel again to disable scrolling.

About the Tabular Trend Display

The following illustration shows the Tabular trend display.



Time	HR	NBP	SpO_2	Temp	RESP
03:30:00	85 ECG		98	37.3	20
03:29:45	87 ECG		98	37.3	21
03:29:30	87 ECG		98	37.3	21
03:29:15	88 ECG		99	37.3	22
03:29:00	89 ECG	122/85 (98)	99	37.3	22
03:28:45	89 ECG		99	37.3	22
03:28:30	87 ECG		98	37.3	23
03:28:15	87 ECG		98	37.3	22
03:28:00	85 ECG		98	37.3	22
03:27:45	85 ECG		98	37.3	24
03:27:30	85 ECG		99	37.3	23
03:27:15	85 ECG		99	37.3	22
03:27:00	85 ECG		99	37.3	22
03:26:45	86 ECG		98	37.0	22
03:26:30	86 ECG		98	38.0	22
03:26:15	85 ECG		94	38.0	22
03:26:00	85 ECG	122/85 (98)	97	38.0	22

The most recent measurement is displayed in the top row of the Tabular trend display. Each row begins with the time at which the measurement was taken, followed by the parameter values.

The monitor stores all continuous measurements in the trend database every 15 seconds and all aperiodic measurements (for example, NBP) at the time the measurement is started. You can configure the Tabular trend display to show all measurements (every 15 seconds) or you can filter the data that appears in the Tabular trend display. For example, you can choose to display data only when an NBP interval measurement occurs. For more information, see “Changing the Display Interval” on page 11-10.

Any measurement that exceeds alarm limits is enclosed in a box.

Changing the Tabular Display Settings

Use the **Tabular Trend Menu** to:

- Change the parameters that appear in the display
- Change the display interval
- Export trend data to a spreadsheet

To open the **Tabular Trend Menu**:

Step	
1	 Trend Menu button With the Tabular display open, rotate the wheel until the **Trend Menu** button is highlighted.
2	Press the wheel. The **Tabular Trend Menu** appears. The first time you open the Tabular trend display**,** a message prompts you to select the parameters you want to display. See the next section, "Selecting Parameters for the Tabular Display."

Selecting Parameters for the Tabular Display

The monitor can display up to six parameters in the Tabular trend display. If you try to select more than six, a message informs you that you have exceeded the maximum number of parameters.

If a parameter is selected in the **Tabular Trend Menu**, but that parameter is not currently being measured, the column header appears in the Tabular trend display, but the column is blank. If a parameter is not selected in the **Tabular Trend Menu**, the column for that parameter is removed from the Tabular trend display.

To change the displayed parameters:

Step	
1	Open the **Tabular Trend Menu**. All available parameters (based on your monitor's configuration) are listed.
2	Rotate the wheel to highlight a parameter and then press the wheel to select or deselect the check box next to the parameter: ✓ = The parameter will appear in the trend display. No ✓ = The parameter will not appear in the trend display.
3	Rotate the wheel until the **Return** button is selected and press the wheel to return to the tabular display. The parameter selections are saved and will reappear the next time you open the Graphical trend display.

Note — You cannot change the order in which the parameters are displayed.

Changing the Display Interval

The monitor stores continuous measurement data every 15 seconds. You can configure the Tabular trend display to show all stored measurements or you can select a different interval value, for example 30 minutes.

To change the display interval in the Tabular trend display:

Step	
1	Open the **Tabular Trend Menu** and rotate the wheel until the **Display Interval** option is highlighted.

2	Press the wheel and then rotate it to select one of the following options: **All Measurements**, **NBP Only**, **1 minute**, **3 minutes**, **5 minutes**, **10 minutes**, **15 minutes**, **30 minutes**, **60 minutes**, **90 minutes**, **120 minutes**, or **Alarms**. If you select **All Measurements**, a new set of measurements displays every 15 seconds; if you select **NBP Only**, a set of measurements displays when an NBP measurement occurs; if you select **Alarms,** only measurements that exceed specified alarm limits are displayed.
3	Press the wheel to save the selected option.
4	Rotate the wheel until the **Return** button is selected and press the wheel to return to the Tabular display.

Scrolling Through the Tabular Display

To scroll through the tabular display:

Step	
1	Rotate the wheel to highlight the tabular display.
2	Press the wheel to enable the scroll bar on the right side of the display.
3	Rotate the wheel clockwise to view older data or counter-clockwise to view the newest trend data.
4	Press the wheel again to disable scrolling.

Exporting Tabular Trend Data

The **Tabular Trend Menu** contains an **Export** button that can be used to export Tabular trend data to a USB flash drive. The exported file is a space-delimited .csv file with the name TrendLog_*PatientID*.csv.

Warning **When you export trend data to a USB flash drive, the file name contains the associated patient ID. Ensure that the exported data is handled according to your facility's electronic protected health information (ePHI) guidelines. Only authorized personnel should be allowed to view, store or transmit patient data.**

Philips recommends using a SanDisk® or Kingston® USB flash drive.

To export Tabular trend data:

Step	
1	Open the **Tabular Trend Menu**.
2	Select a Display Interval for the trend data you want to export.
3	Insert a USB flash drive in the USB port on the back of the monitor.
4	Rotate the wheel until the **Export** button is selected and press the wheel. A message indicates that the trend data has been exported.

Printing Trend Data

Note — You can print Tabular trend data, but you cannot print Graphical trend data.

For information on printing Tabular trend data, see "Printing Trend Data" on page 12-6.

12
Printing

This chapter describes how to:

- Load the recorder paper
- Print the current patient's data
- Enable the monitor to print on alarm

You can use the recorder in normal monitoring mode, Trend mode, or SpotCheck mode. This chapter describes how to print in normal monitoring mode and in Trend mode. For information on printing SpotCheck data, see Chapter 13, "SpotCheck Mode."

Warning **Printed and exported patient records contain patient IDs and patient data. Ensure that the printed or exported data is handled according to your facility's electronic protected health information (ePHI) guidelines.**

Only authorized personnel should be allowed to view, handle, store, or transmit patient data.

Loading the Recorder Paper

Caution **Use only Philips-supplied paper. Using the wrong paper can damage the recorder. If the paper is inserted incorrectly, no data is printed.**

To load the paper in the recorder:

Step	
1	Press the paper eject button on the left side of the recorder door to open the door. If the door does not open completely, pull it toward you.
2	Remove the empty paper core.
3	Place a new roll in the holder so that the end comes from the back over the top of the roll and slide the paper through the slot in the door. 
4	Pull the loose edge to remove any slack and close the recorder door.
5	Press the **Print** key to verify that the paper is loaded correctly.

Printing Options


Print key

In normal monitoring mode, use the **Print** key on the front panel of the monitor to create a snapshot or a continuous printout.

Snapshot Printing

Press and release the **Print** key to produce a recording of waveform data and all current vital signs measurements.

Use the **Waveform Print** option in the **System Menu** to select the length of the printed waveform. The **Waveform Print** options are:

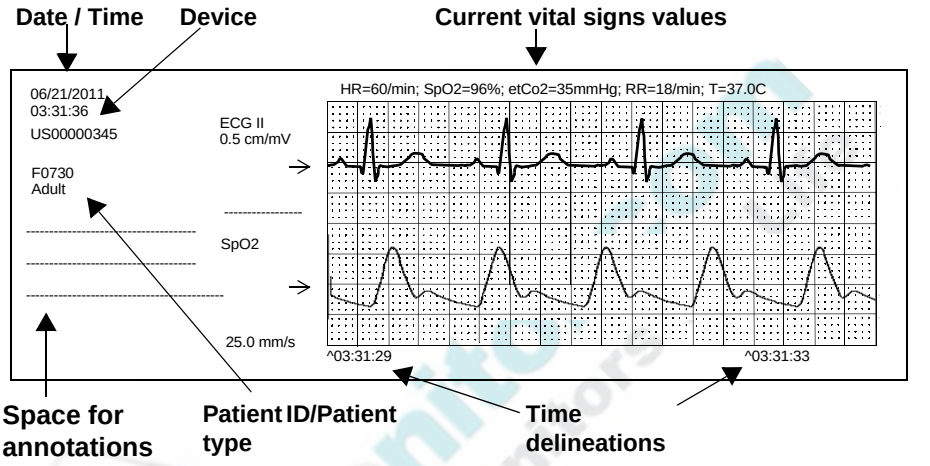
- **20 seconds** — The printout contains the values that occurred 7 seconds before and 13 seconds after the **Print** key was pressed.
- **7 seconds** — The printout contains the values that occurred 7 seconds after the **Print** key was pressed.

Continuous Printing

Press and hold the **Print** key for 2 seconds to generate a continuous recording of all current data. The recorder will continue printing until you press the **Print** key again to stop the recording.

Print Format

Both the Snapshot and Continuous printouts contain a header, followed by one or more waveforms.



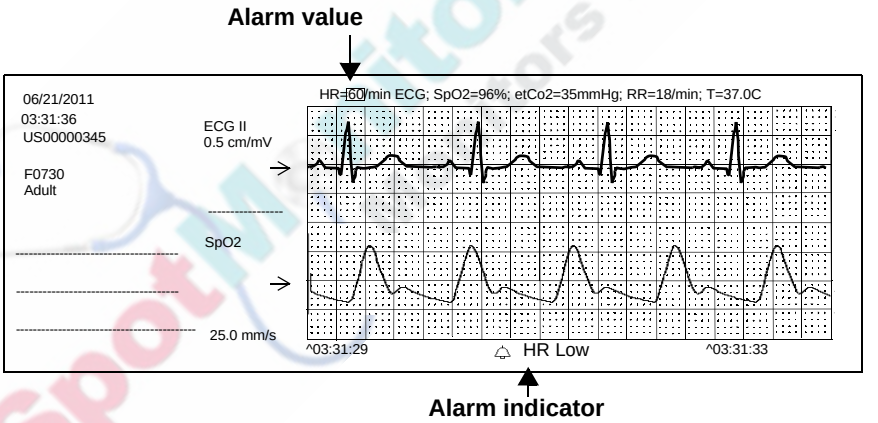
Note — If the screen contains one ECG waveform and at least one other waveform, the printed ECG waveform is half the size of the ECG waveform on the screen. For example, if the ECG scale is set to 2.0 cm/mV on the screen, the printed ECG waveform will be 1.0 cm/mV.

Enabling Print on Alarm

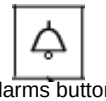
You can configure the SureSigns VM Series patient monitors to automatically generate a printout when a physiological alarm occurs. After a measurement is taken, and the monitor determines that the value is outside the alarm limits, the recorder produces a printout.

Note — If your monitor is connected to a VSV, and you enable **Print on Alarm**, the printout is initiated at the bedside monitor, not at the VSV.

An alarm icon and alarm message appear along the bottom of the printout to indicate the approximate time that the alarm occurred. The measurement that triggered the alarm appears in a box at the top of the printout.



To enable the print on alarm feature:

Step	
1	 Alarms button — Rotate the wheel until the **Alarms** button is highlighted and then press the wheel to display the **Alarm Menu.**
2	Rotate the wheel until the **Print on Alarm** check box is highlighted.
3	Press the wheel until the desired setting appears. ✓ = Print on Alarm is enabled No ✓ = Print on Alarm is disabled
4	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Enabling NBP Auto Print

To configure the monitor to initiate a printout each time an NBP measurement is taken, see “Enabling Auto Print NBP” on page 5-6.

Printing Trend Data

Note — You can print Tabular trend data, but you cannot print Graphical trend data.

You can print the most recent tabular trend entry or several entries within a specified period of time.

To print Tabular trend data:

Step	
1	With the Tabular trend display open, press the **Print** key on the front panel of the monitor. The **Print Trend Menu** appears.
2	Rotate the wheel to highlight a print range. The following options are available: **Most Recent**, **1 hour**, **2 hours**, **4 hours**, **8 hours**, and **12 hours**. If you select **Most Recent**, the printout contains one trend entry (the most recent entry). The number of entries in the printout depend on the configured display interval. So, for example, if the **Display Interval** is set to 15 minutes and you select **1 hour** in the **Print Trend Menu,** the printout contains 5 entries, 15 minutes apart.
3	Press the wheel to print the trend data.

Changing the Recorder Speed

You can change the recorder speed in the **System Menu**. See “Changing System Settings” on page 2-26.

13
SpotCheck Mode

The SureSigns VM4 patient monitor can be used as a spot check device. When the monitor is in SpotCheck mode, you can easily move from one patient to another to take a set of vital signs measurements without sounding alarms. Each SpotCheck measurement is saved to the SpotCheck database and displayed in a tabular format at the bottom of the screen.

Note — SpotCheck mode is only available on the SureSigns VM4 monitor.
If your SureSigns VM4 monitor is connected to a VSV, and you place it in SpotCheck mode, the monitor disconnects from the VSV network and displays the message **In SpotCheck Mode** at the VSV.

Alarms in SpotCheck Mode

All physiological alarms are disabled in SpotCheck mode.

Most technical alarms in SpotCheck mode produce visual alarm indicators, but no audible alarms. The exceptions are:

- NBP Overpressure
- Low Battery
- Extreme Low Battery

These three technical alarms produce both visual and audible alarms.

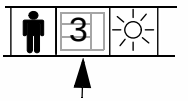
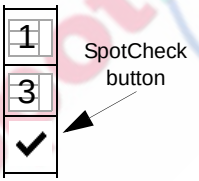
Alarm Silence key

To clear a technical alarm in SpotCheck mode, press the **Alarm Silence** key on the front panel of the monitor.

Warning **Because the SpO2 Non-Pulsatile and SpO2 No Sensor technical alarms are not useful if you connect and disconnect sensors between patients, these alarms are disabled when the VM4 monitor is in SpotCheck mode. If the sensor falls off the patient or becomes disconnected from the monitor, no alarm occurs.**

Enabling SpotCheck Mode

To enable SpotCheck mode:

Step	
1	 Display Mode button Rotate the wheel until the **Display Mode** button is highlighted.
2	Press the wheel. The **Display Mode** menu appears and the currently active layout is highlighted.
3	 Turn the wheel to select the **SpotCheck** button and press the wheel again. The SpotCheck layout is active.

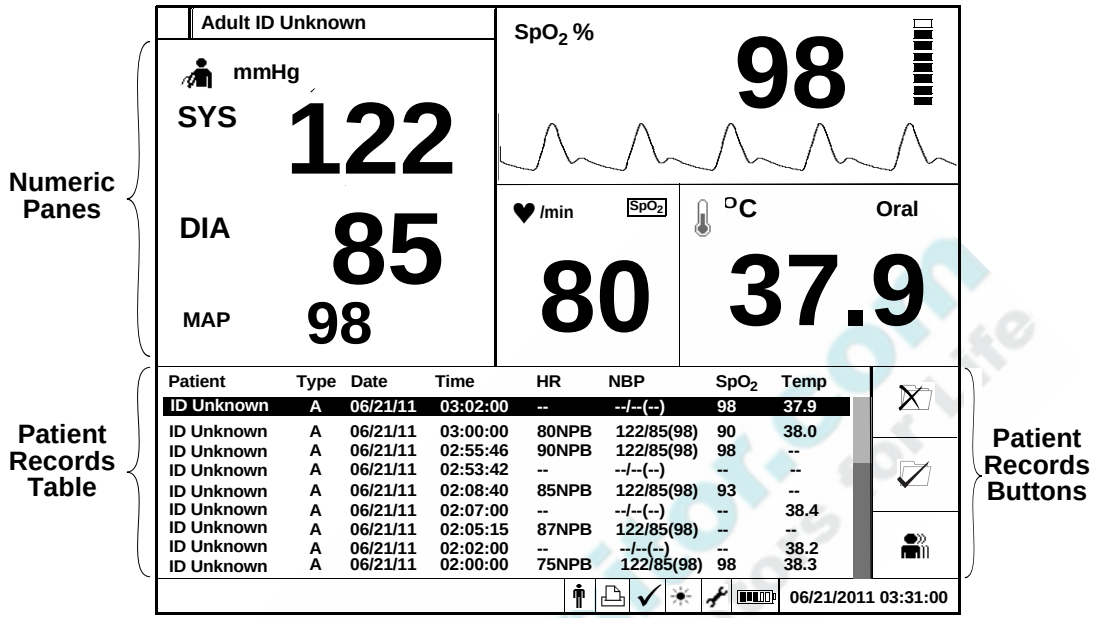
The SpotCheck screen contains four numeric panes: NBP, SpO_2, Heart Rate, and Temperature.

The patient records table at the bottom of the screen contains all SpotCheck records. Each entry contains a patient ID (or **ID Unknown**), the patient type, date and time, and up to four measurements. The timestamp shows the time at which the last measurement completed.

The following table describes the buttons that appear to the right of the patient records table. These buttons change, depending on whether the topmost record is open or closed.

Button	Button Name	Description
	**Delete**	If the record is closed, select the **Delete** button to delete the saved record.
	**Edit**	If the record is closed, select the **Edit** button to edit the record.
	**Cancel**	If the record is open, select the **Cancel** button to discard the record before it is saved to the database.
	**Save**	If the record is open, select the **Save** button to save the record.
	**View Records**	Select the **View Records** button to toggle between **View Patient** mode and **View All** mode. Select **View Patient** mode to view all records for a specific patient. Select **View All** mode to view all records in the Patient Records table.

See the procedures later in this chapter for detailed information on using these buttons.



Taking a SpotCheck Measurement

After placing the monitor in SpotCheck mode, follow these steps to take a set of vital signs measurements on a patient.

Note — You do not have to enter a patient ID to take a set of measurements. However, only records that have a primary patient ID can be exported over a LAN network connection. If a record does not contain a primary ID (**ID Unknown** appears in the patient record), the data is not exported. If you are unsure if a patient ID is required, see your system administrator. For more information on patient IDs, see "Starting a New Patient" on page 2-17.

Step	
1	Enter a patient ID as described in Chapter 2. To enter a patient ID: • Manually, see "Entering Patient IDs Using the On-screen Keyboard" • Using a standard barcode scanner, see "Entering Patient IDs by Scanning Individual Barcodes" • Using a programmed barcode scanner, see "Entering Patient IDs with a Programmed Barcode Scanner" A new row and the patient ID you just entered appears at the top of the patient records table. The text in the new row is red.
2	Rotate the wheel until the **OK** button is selected and press the wheel to close the **New Patient Menu**. A new row and the patient ID you just entered appears at the top of the patient records table. The text in the new row is red.
3	Begin taking vital signs measurements on the new patient.
4	When all measurements are complete, the values appear in the new record.
5	Rotate the wheel until the **Save** button is highlighted. Press the wheel to save the new patient record. After the information is saved, the text changes from red to black. If you do not want to save the measurement, select the **Cancel** button. If you do not press the **Save** button or **Cancel** button within 60 seconds, the monitor automatically saves the measurement.

Note — If the SpO_2 sensor remains connected to the patient after the patient record is saved, the monitor continues to measure and display SpO_2 (and Heart Rate, if it is derived from SpO_2), but does not create a new patient record. SpotCheck mode is not intended for continuous monitoring.

Selecting an Existing ID for a SpotCheck Measurement

Once a patient ID has been entered in the SpotCheck database, you can select the saved ID in the **New Patient Menu** and take another set of measurements on the same patient. You do not have to re-enter the ID.

Note — If your system administrator has enabled barcode scanning on your monitor, the **Patient ID** list is unavailable.

To select an existing patient ID:

Step	
1	 New Patient button — Rotate the wheel until the **New Patient** button is highlighted.
2	Press the wheel. The **New Patient Menu** appears. Existing patient IDs appear in the **Patient ID** list.

3	If you want to sort the list, click on the **List Sorted By** button. The existing entries in the **Patient ID** list can be sorted by **Name**, primary ID, or patient type. **Note —** *Select the* **List Sorted By** *button again to reverse the sort order (for example, A-Z becomes Z-A).*
4	Rotate the wheel until the **Patient ID** list is highlighted and press the wheel.
5	Rotate the wheel to select the desired patient ID and press the wheel.
6	Rotate the wheel until the **OK** button is selected and press the wheel to close the **New Patient Menu**. The selected patient ID appears in the patient pane at the top of the screen and in the patient list in the SpotCheck table.
7	After taking the new measurements, rotate the wheel until the **Save** button is highlighted. Press the wheel to save the measurements to the SpotCheck database.

Viewing Records in the SpotCheck Database

SpotCheck records are displayed in chronological order. The most recent record appears at the top of the patient records table. The database can hold up to 100 records. If you try to save more than 100 records, the oldest entry is deleted from the database to make room for the newest entry.

The patient records table displays six records at one time. If the table contains more than six records, a scroll bar appears, allowing you to scroll through all of the records in the patient records table. You can also view all records for a specific patient.

The **View Records** button in the lower right corner of the screen toggles between two modes: **View Patient** and **View All**. Use **View Patient** mode to view all records for a specific patient. Use **View All** mode to view all records in the SpotCheck table**.**

Note — When you select the **View Records** button, the name changes to the opposite mode: if you select **View Patient**, the button name changes to **View All**; likewise, if you select **View All**, the button name changes to **View Patient**.

To scroll through all of the records:

Step	
1	Rotate the wheel until the patient records table is highlighted.
2	Press the wheel to enable the scroll bar on the right side of the table.
3	Rotate the wheel to scroll through all of the records. Press the wheel again to exit scrolling mode.

Note — If you add a new record while scrolling mode is active, the table automatically scrolls to the top and exits scrolling mode.

To scroll through all records for a specific patient:

Step	
1	Rotate the wheel until the patient records table is highlighted.
2	Press the wheel.
3	Rotate the wheel until the desired patient ID is highlighted and press the wheel again.
4	Rotate the wheel until the **View Patient** button is highlighted and press the wheel again. The patient records table displays all records for the selected patient.
5	To exit this view, press the wheel again.

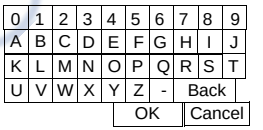
Editing a Patient ID

If you saved a SpotCheck record with an incorrect patient ID or you want to change **ID Unknown** to an actual patient ID, you can edit the patient ID as described in the following procedures.

Note — Once you enter a patient ID and then exit the **New Patient Menu**, you can no longer change the **Patient Type**. This is because the default alarm values are based on the selected patient type.

Note — Once a record has been exported, it can no longer be edited. Exported records appear green in the patient records table.

To manually edit a patient record:

Step	
1	Rotate the wheel until the patient records table is highlighted and press the wheel.
2	Rotate the wheel until the desired patient record is highlighted and press the wheel again.
3	 Edit button Rotate the wheel until the **Edit** button is highlighted and press the wheel. The **Edit Patient Menu** appears.
4	Use one of the following methods to edit the ID: • To replace the selected ID with an ID that already exists in the SpotCheck database, select the ID from the Patient ID list and skip to Step 7. • To replace the selected ID using a barcode scanner, rotate the wheel to highlight the field you want to replace and scan the barcode. Repeat for each ID that needs to be replaced and skip to Step 7. • To edit the selected ID, rotate the wheel to highlight the field you want to edit and press the wheel. A keyboard appears. 
5	Rotate the wheel until the **Back** key on the keyboard is highlighted. Press the wheel to erase the incorrect ID.

6	Enter a new ID by rotating the wheel to select each character and pressing the wheel after each selection. When you are done entering the new ID, rotate the wheel to select the **OK** button and press the wheel.
7	Rotate the wheel until the **OK** button is selected and press the wheel to close the **Edit Patient Menu**. A message asks if you are sure you want to change the patient ID.
8	Rotate the wheel until the **Yes** button is selected and press the wheel. The new ID replaces the old one in the patient records table.

Deleting SpotCheck Records

Use the **Delete** button to delete:

- One SpotCheck record
- All records for a specific patient
- All records in the SpotCheck database

Note — If you delete all records for a specific patient, the patient ID for the deleted patient is also removed from the patient list in the **New Patient Menu**.

The options that appear in the **Delete Records Menu** depend on which View mode is active.

- **If View Patient mode is enabled**, you can delete a specific SpotCheck record or all records for the selected patient.
- **If View All mode is enabled**, you can delete a specific SpotCheck record, all records for a specific patient, or all records in the SpotCheck database.

Deleting Specific SpotCheck Records

To delete one SpotCheck record or all records for a specific patient:

Step	
1	Rotate the wheel until the patient records table is highlighted.
2	Press the wheel.
3	Rotate the wheel until the desired patient ID is highlighted and press the wheel again.
4	Rotate the wheel until the **View Patient** button is highlighted. Press the wheel to display all saved records for the selected patient.
5	 Delete button Rotate the wheel until the **Delete** button is highlighted and press the wheel. The **Delete Records Menu** appears. The patient ID and patient type for the selected record appear in the top of the menu.
6	Rotate the wheel to select one of the following options and press the wheel to check the box: • **Delete the selected patient record** • **Delete all records for selected patient**
7	Rotate the wheel until the **OK** button is highlighted and press the wheel. A confirmation window opens.
8	Rotate the wheel to select **Yes** and press the wheel. The record(s) are deleted.

Deleting All SpotCheck Records

To delete all records in the SpotCheck database:

Step	
1	Make sure **View All** mode is enabled.
2	 Delete button Rotate the wheel until the **Delete** button is highlighted and press the wheel. The **Delete Records Menu** appears.
3	Rotate the wheel until the **Delete all records** option is highlighted and press the wheel to check the box.
4	Rotate the wheel until the **OK** button is highlighted and press the wheel. A confirmation window opens.
5	Rotate the wheel to select **Yes** and press the wheel. All patient records are deleted.

Printing in SpotCheck Mode

If your monitor has a recorder, you can print one record, several records, or all saved records:

- **To print the highlighted record**, press the **Print** key on the front panel.
- **To print multiple records**, use the following procedure.

Step	
1	 View Records button Rotate the wheel until the **View Records** button is highlighted and select a view mode: • Enable **View All** mode to print multiple records from the patient record table. • Enable **View Patient** mode to print multiple records for a specific patient.
2	 Print button Rotate the wheel until the **Print** button is highlighted. The **Print** button is in the area just below the patient records table.
3	Press the wheel. The **Print Patient Data Menu** appears.

4	Rotate the wheel to highlight the number of records you want to print. The choices are: • **Most Recent** • **10 Records** • **20 Records** • **30 Records** • **40 Records** • **50 Records** • **All Records**
5	Press the wheel. The recorder prints the selected number of records.

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14
VSV Networked Monitoring

This chapter describes how to use a SureSigns VM monitor that is connected to a VSV network.

For information on using the SureSigns VSV, see the *SureSigns VSV Instructions for Use*. For information on installing the SureSigns VSV, see the *SureSigns VSV Installation and Setup Guide*.

VSV Network Overview

This section provides an overview of the VSV network. Before using your networked monitor, you should have a basic understanding of the features and functionality of the VSV network.

Verifying the Network Connection

The Connectivity icon, which appears in the upper left corner of the main screen, indicates the status of the VSV network connection.

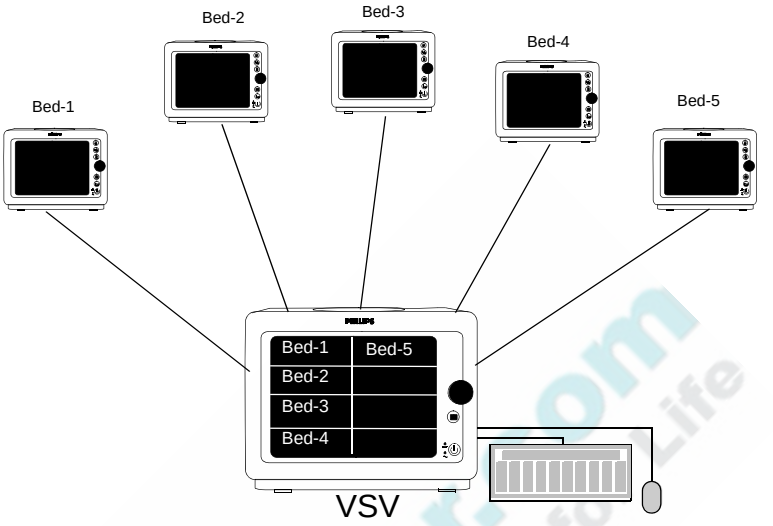
Icon	Connection Status
	The monitor is currently connected to the VSV network.

Icon	Connection Status
	The red X over the network icon indicates that the monitor is no longer connected to the VSV network. The **No Central Monitoring** message appears in the message area. Check the connection on the back of the monitor. If the message persists, contact your system administrator.
No icon	If the pane is empty, the monitor was explicitly removed from the VSV network or was never added to the network.

Note — If you place a SureSigns VM4 monitor in SpotCheck mode, the monitor disconnects from the VSV and the message **In SpotCheck Mode** is displayed at the VSV. SpotCheck measurements are stored locally in the monitor's SpotCheck database; they are not sent to the VSV.

Naming the Monitor

Each monitor is identified at the VSV by the monitor name. During the VSV installation, your system administrator assigns a name to each monitor and then assigns each monitor to a viewing pane at the VSV. The monitor name is typically a room number or some other unique identifier that tells the VSV which monitor is sending patient data.



If you change the monitor name (in the **System Menu**), be sure the new name is unique and that it follows the same naming convention as the existing names. For example, in the sample VSV network above, you would not change "**Bed-2**" to "**Room-16**" because all other monitors are identified by bed number, not room number.

The system does not prevent you from duplicating monitor names. If you move the monitor to a new location, be sure to change the monitor name to match the new location.

Starting a New Patient

Use one of the following methods to start a new patient on a networked monitor:

- Select the patient ID/patient name from the VSV Patient List
- Start a new patient with no Patient ID.

You can also manually enter a patient ID at the bedside monitor, as described in "Starting a New Patient" on page 2-17, but an ID entered at the bedside is not saved to the VSV patient list. The ID does appear in the corresponding VSV pane while the patient is being monitored, but it is not saved to the VSV patient list.

Caution **Before you begin monitoring, be sure that the correct patient type is selected. The monitor's default alarm limits are based on the selected patient type.**

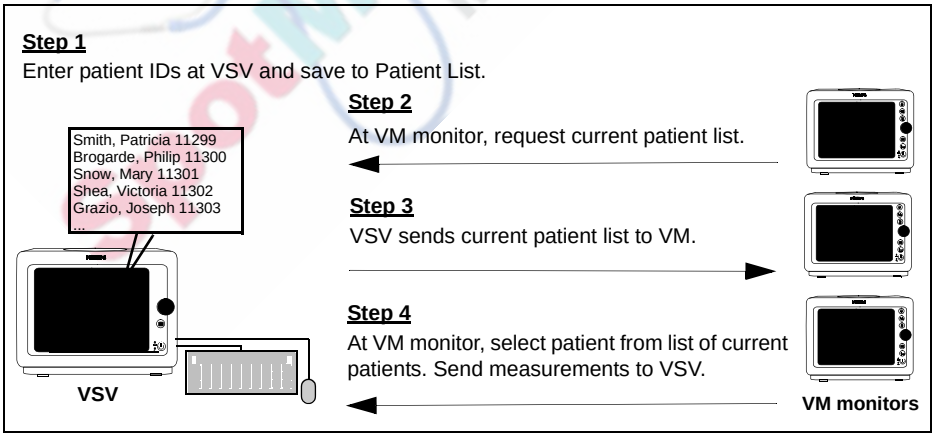
If you change the patient type in the patient list at the VSV, the change is not automatically reflected at the bedside monitor. You must readmit the patient at the bedside by selecting the updated entry from the New Patient List in the New Patient Menu.

If you change the patient type at the bedside monitor, the change is not sent to the VSV patient list.

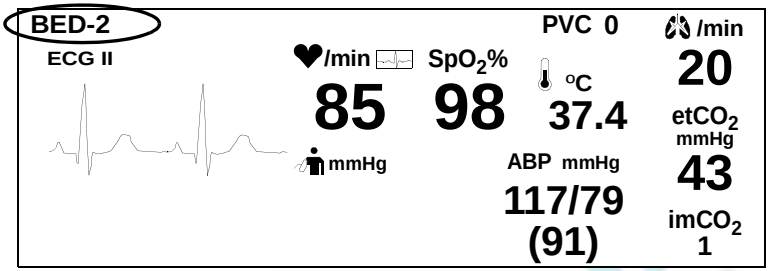
Selecting a Patient ID/Patient Name from the Patient List

Patient information, including the patient name, patient ID, and patient type, is entered at the VSV and saved to the Patient List. To admit a patient at the bedside monitor, you open the **New Patient Menu** and select the patient from the list of patients saved at the VSV.

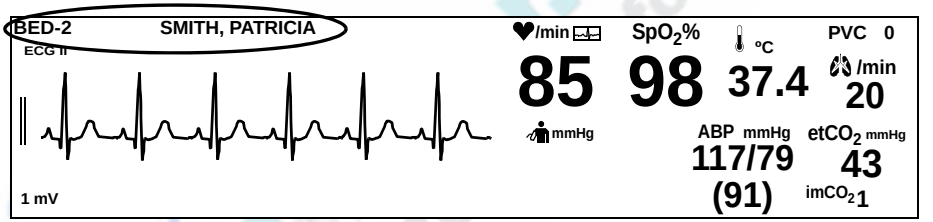
Note — If your system administrator has enabled barcode scanning on your monitor, **Select Patient ID from VSV** is not available.



After you admit the patient, the monitor name appears in the corresponding pane at the VSV.

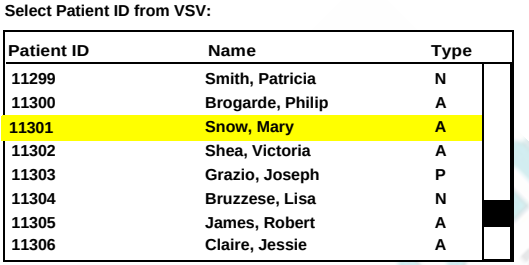


If you enlarge the pane at the VSV, the monitor name and the patient name are displayed, as seen in the following illustration.



To select a patient from the VSV patient list:

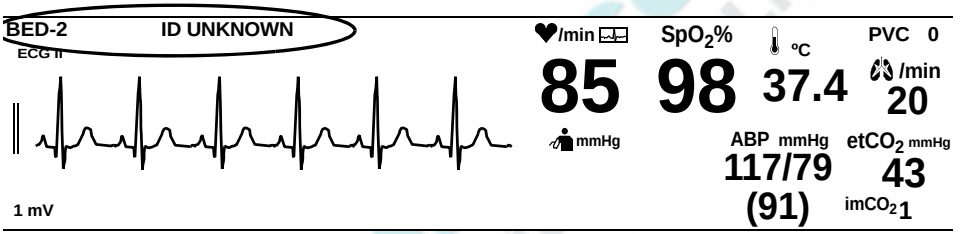
Step	
1	Rotate the wheel until the **New Patient** button is highlighted.

2	Press the wheel. The **New Patient Menu** appears. The **Select Patient ID from VSV** list box displays a list of all patient entries currently stored at the VSV.  **Note —** *The system does not prevent you from admitting the same patient to two different bedside monitors. Be careful not to select a patient already admitted at a different bedside monitor.*
3	Rotate the wheel to highlight the **Refresh** button and press the wheel. The patient list is updated.
4	Optionally, select the **List Sorted By** menu item to sort the list by patient name, patient ID, or patient type.
5	Rotate the wheel to highlight the **Select Patient ID from VSV** list box and press the wheel.
6	Rotate the wheel to highlight the entry for the patient you want to admit and press the wheel.
7	Rotate the wheel until the **OK** button is selected and press the wheel to close the **New Patient Menu** and return to the main screen. The monitor name and the selected patient type, patient ID, and patient name appear in the top left corner of the bedside monitor's main screen. You can now begin taking vital signs measurements.

Starting a New Patient with No Patient ID

Caution **If you do not select a patient ID from the VSV Patient List, you must still ensure that the correct patient type is selected. The monitor's default alarm limits are based on the selected patient type.**

If you choose not to select a patient from the Patient List, the monitor name appears in the corresponding pane at the VSV. If you enlarge the pane at the VSV, the monitor name and **ID Unknown** is displayed in the VSV viewing pane, as seen in the following illustration.



Synchronizing the Date and Time

Use one of the following methods to synchronize the date and time between the VM bedside monitor and the VSV:

- Open the **New Patient Menu** to start a new patient.
- Select the **Synchronize** button in the **Date / Time Menu** as follows:

Step	
1	Rotate the navigation wheel until the date and time pane is highlighted. The date and time pane is in the lower right corner of the main screen.

2	Press the wheel. The **Date / Time Menu** appears.
3	Rotate the wheel until the **Synchronize** button is highlighted and press the wheel.

If the clock is adjusted, a blue line appears in the graphical and tabular trend displays of the monitor. If the clock is adjusted by more than 30 seconds, the monitor also displays a **Date / Time Adjusted** alarm message; if the monitor is taking automatic NBP interval measurements, the monitor starts a new NBP measurement.

If the date and time are *not* synchronized between the bedside monitor and the VSV, and you initiate a recording at the VSV, the printout contains the date and time from the bedside monitor.

Selecting a VSV Waveform

The VSV can display one waveform per patient. To specify which waveform appears at the VSV, use the **VSV Waveform Display** option in the **System Menu**.

To select a VSV waveform:

Step	
1	 Rotate the wheel until the **System** button is highlighted.
2	Press the wheel. The **System Menu** appears. Current settings are displayed.
3	Rotate the wheel to highlight the **VSV Waveform Display** field and press the wheel.

4	Rotate the wheel to select one of the following options. Available options are based on the number of waveforms currently displayed in the main screen. • **Top** • **Second** • **Third** • **Fourth** So, for example, if you select **Second**, and the second waveform pane on the monitor contains an SpO_2 waveform, the SpO_2 waveform displays at the VSV.
5	Press the **Main Screen** key on the front panel to close the menu. **Alternative:** Rotate the wheel until the **Main Screen** button is selected and press the wheel.

Top is the default value for the **VSV Waveform Display** option. If you change the screen layout to Big Number format or you place the monitor in SpotCheck mode, the **VSV Waveform Display** setting returns to the default value.

If you place the monitor in Trend mode, the setting temporarily changes to **Top** and then returns to the previously selected setting once the monitor is taken out of Trend Mode.

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15
Care and Cleaning

To clean or disinfect your SureSigns VM Series patient monitor, use only the approved cleaning agents listed in this chapter.

For information on how to clean accessories, see the instructions for use provided with the accessory.

Warning **Do not use unapproved cleaning or disinfecting agents. Even small quantities of some cleaning agents will damage the monitor.**

Do not use abrasive cleaners or strong solvents such as acetone or acetone-based compounds. The warranty does not cover damage caused by using unapproved substances.

General Guidelines

Keep the monitor, cables, and accessories free of dust and dirt. After cleaning and disinfecting, check the equipment carefully. Do not use them if you see signs of deterioration or damage.

If you need to return any equipment to Philips, clean and disinfect it first.

Follow these general precautions:

- Always dilute cleaning agents according to the manufacturer's instructions or use the lowest possible concentration.
- Do not allow liquid to enter the case.
- Do not immerse any part of the equipment in liquid.
- Do not pour liquid onto the system.
- Never use abrasive material (such as steel wool or silver polish).
- Do not autoclave, steam sterilize, or ultrasonically clean the monitor or cables.
- Do not use bleach on electrical contacts or connectors.

Caution **If you spill liquid on the exterior of the monitor, use a clean cloth to dry the monitor. If you believe the liquid may have gotten inside the monitor, contact your biomedical engineer, who can verify the performance and safety of the unit.**

Cleaning and Disinfecting the Monitor

To clean the monitor:

Step	
1	Dampen a soft cloth with mild soap and water.
2	Wring any excess moisture from the cloth and gently clean the monitor.

To disinfect the monitor:

Step	
1	Dampen a soft cloth with either of the following: • Isopropyl alcohol (70% solution in water) • Sodium hypochlorite (chlorine bleach, 5% solution in water)
2	Wring any excess moisture from the cloth and wipe the monitor to disinfect it.

Note — If you have a VM4 or VM6 monitor manufactured after July 2010, you can also use the following materials to disinfect the monitor:

- Isopropyl alcohol (70% solution in water)
- Sodium hypochlorite (chlorine bleach, 5% solution in water)
- Quaternary ammonium chloride compounds (<0.25%)
- Hydrogen peroxide (<5%)
- Peracetic acid (<1%) with Hydrogen peroxide (<1%)
- Sodium dichloroisocyanurate solid (48% before dilution)
- Ethylene glycol monobutyl ether (2.5%) with isopropanol (14%)

You can find the date of manufacture on the rear of the monitor, as shown below:

Cleaning and Disinfecting the Cables

Caution **Do not use alcohol to clean the cables. Alcohol can cause the cables to become brittle and fail prematurely.**

To clean the cables:

Step	
1	Dampen a soft cloth with alcohol-free hand soap.
2	Wring any excess moisture from the cloth and gently clean the cables.
3	Clean the areas again with a damp cloth moistened with water only.

To disinfect the cables:

Step	
1	Dampen a soft cloth with sodium hypochlorite (chlorine bleach), 3% solution in water. **Caution: Sodium hypochlorite may discolor the cable.**
2	Wring any excess moisture from the cloth and gently clean the cables.
3	Clean the areas again with a damp cloth moistened with water only.

Cleaning and Disinfecting the VM4 Temperature Probe and Well

When cleaning the VM4 temperature probe and well, follow these general precautions:

- Do not use steam, heat, or gas sterilization on the probe or probe well.
- Do not autoclave the probe well.

Cleaning and Disinfecting the Probe and Cord

To clean the probe and cord:

- Dampen a soft cloth with mild soap and warm water and wipe the probe and cord.

To disinfect the probe and cord:

- Dampen a soft cloth with any of the following solutions and wipe the probe and cord:
  - Isopropyl alcohol (70% solution in water)
  - Sodium hypochlorite (chlorine bleach, 10% solution in water)
  - A nonstaining disinfectant

Cleaning and Disinfecting the Probe Well

To clean and disinfect the probe well:

Step	
1	Disconnect the probe and remove it from the well.
2	Remove the well from the monitor.
3	Dampen a soft cloth with mild soap and water and wipe the inner and outer surfaces.
4	If needed, disinfect the well with any of the following: • Isopropyl alcohol (70% solution in water) • Sodium hypochlorite (chlorine bleach, 10% solution in water) • A nonstaining disinfectant
5	Thoroughly dry all of the surfaces before replacing the well in the monitor.

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16
Accessories List

This chapter lists accessories that are compatible with the SureSigns VM Series patient monitors.

Note — The accessory list is subject to change. For the latest information on supported accessories, contact your authorized Philips representative or refer to www.medical.philips.com.

SpO_2 Accessories

Philips Reusable Sensors

Caution **Do not connect extension cables to SpO_2 sensors with a part number that ends in L (for example, M1191BL).**

Patient Category	Description	Cable Length	Part Number	Use With This Cable
Adult	Finger sensor, for patient size >110 lb (50kg)	2 m	M1191B	Extension Cable M1941A (2 m)
Pediatric/ small adult	Finger sensor, for patient size 33 - 110 lb (15 - 50 kg)	1.5 m	M1192A	
Neonatal	Foot/hand sensor, for patient size 2.2 - 8.8 lb (1 - 4 kg)	1.5 m	M1193A	
Adult	Ear clip sensor, for patient size > 88 lb (40kg)	1.5 m	M1194A	
Infant	Finger sensor, for patient size 8.8 - 33 lb (4 - 15 kg)	1.5 m	M1195A	
Adult	Finger sensor, for patient size >110 lb (50kg)	3 m	M1191BL	No extension cable
Adult	Finger clip, for patient size >88 lb (40kg)	3 m	M1196A	

Patient Category	Description	Cable Length	Part Number	Use With This Cable
Adult	Finger sensor, for patient size > 110 lb (50 kg)	45 cm	M1191T	Adapter Cable M1943A (1.1 m) or M1943AL (3 m)
Pediatric	Finger sensor, for patient size 33 – 110 lb (15 – 50 kg)	45 cm	M1192T	
Neonatal	Foot/hand sensor, for patient size 2.2 – 8.8 lb (1 – 4 kg)	90 cm	M1193T	
Pediatric/ Adult	Finger sensor, for patient size > 88 lb (40 kg)	90 cm	M1196T	

Philips Disposable Sensors

Patient Category	Description	Part Number	Use With This Adapter Cable
Adult/ Pediatric	Finger sensor, for patient size > 44 lb (20 kg)	M1131A	M1943A (1.1 m) or M1943AL (3 m)
Infant	Digit sensor for patient size 7 - 22 lb (3 - 10 kg)	M1132A	
Neonatal/ Infant/Adult	Foot/hand sensor for neonate; big toe/thumb for infant; finger for adult. Neonate patient size, < 7 lb (3 kg); Infant patient size, 22 - 44 lb (10 - 20 kg); Adult patient size, > 88 lb (40 kg)	M1133A	
Neonatal/ Infant/Adult	Adhesive-free foot/hand sensor for neonate; big toe/thumb for infant; finger for adult. Neonate patient size, < 7 lb (3 kg); Infant patient size, 22 - 44 lb (10 - 20 kg); Adult patient size, > 88 lb (40 kg)	M1134A	

Nellcor Disposable Sensors

Note — The Nellcor disposable sensors listed below are only available in Europe and Japan.

Patient Category	Description	Part Number	Use With This Adapter Cable
Neonate/ Adult	Sensor for neonatal foot or adult digit, for patient size <7 lb or > 88 lb (<3 kg or >40 kg)	M1901B	M1943A (1.1 m) or M1943AL (3 m)
Infant	Digit sensor, for patient size 7 - 44 lb (3 - 20 kg)	M1902B	
Pediatric	Digit sensor, for patient size 22 - 110 lb (10 - 50 kg)	M1903B	
Adult	Digit sensor, for patient size >66 lb (>30 kg)	M1904B	

Masimo Adapter Cables

Description	Cable Length	Part Number
Masimo LNOP Adapter Cable (adapts LNOP sensors to Philips monitors)	3.6 m	M1020-61100
Masimo LNCS Adapter Cable (adapts LNCS sensors to Philips monitors)	3.0 m	989803148221

ECG Accessories

Note — Trunk cables are not interchangeable. When ordering new lead sets, make sure you have the compatible trunk cable, as listed in the tables below.

Recommended ECG Cables

3-Lead Sets

Description	AAMI Part Number	IEC Part Number	Use With This Trunk Cable
General use/ICU, grabber	M1671A	M1672A	M1669A Cable length 2.7m
General use/ICU, snap	M1673A	M1674A	
OR, grabber	M1675A	M1678A	
General use/ICU miniclip (lead length 0.45m)	M1622A	--	
General use/ICU miniclip (lead length 0.7m)	M1624A	M1626A	

5-Lead Sets

Description	AAMI Part Number	IEC Part Number	Use With This Trunk Cable
General use/ICU, grabber	M1968A	M1971A	M1668A Cable length 2.7m
General use/ICU, snap	M1644A	M1645A	
OR, grabber	M1973A	M1974A	
General use/ICU miniclip	M1647A	M1648A	

Supported ECG Cables

One Piece Sets

Description	AAMI Part Number	IEC Part Number	Cable Length
3 lead, one piece set, grabber, general use/ICU	989803143181	989803143171	2.5 m
5 lead, one piece set, grabber, general use/ICU	989803143201	989803143191	

5-Lead Sets

Description	Color Coding	Part Number	Use With This Trunk Cable
OR use, grabber	AAMI	M1621A	M1520A Cable length 2.7m
General use/ICU, grabber	AAMI	M1623A	
General use/ICU, snaps	AAMI	M1625A	

Description	Color Coding	Part Number	Use With This Trunk Cable
OR use, grabber	IEC	M1631A	M1530A Cable length 2.7m
General use/ICU, grabber	IEC	M1633A	
General use/ICU, snaps	IEC	M1635A	

3-Lead Sets

Description	Color Coding	Part Number	Use With This Trunk Cable
OR use, grabber	AAMI	M1601A	M1500A Cable length 2.7m
General use/ICU, grabber	AAMI	M1603A	
General use/ICU, snaps	AAMI	M1605A	
OR use, grabber	IEC	M1611A	M1510A Cable length 2.7m
General use/ICU, grabber	IEC	M1613A	
General use/ICU, snaps	IEC	M1615A	

ECG Electrodes

Description	Part Number
Silver/silver chloride sensor, foam, pre-gelled (5/pack, 300/case)	40493D
Silver/silver chloride sensor, foam, pre-gelled (30/pack, 300/case)	40493E

NBP Accessories

Note — Thigh cuffs are not supported on monitors with the CAS NBP module. To see which module is installed in your monitor, see “Identifying the NBP Hardware Module” on page 5-15.

Reusable Comfort Cuffs

Patient Category/Cuff Type	Limb Circumference	Bladder Width	Part Number	Hose
Large Adult	34 to 43 cm	16 cm	M1575A	M1598B (1.5m) or M1599B (3m)
Adult	27 to 35 cm	13 cm	M1574A	
Small Adult	20.5 to 28 cm	10.5 cm	M1573A	
Pediatric	14 to 21.5 cm	8 cm	M1572A	
Infant	10 to 15 cm	5.5 cm	M1571A	
Thigh	42 to 54 cm	20 cm	M1576A	

Reusable Traditional Cuffs

Patient Category/Cuff Type	Limb Circumference	Bladder Width	Part Number	Hose
Thigh	46 to 66 cm	17.8 cm	40401E	M1598B (1.5m) or M1599B (3m)
Large Adult	33 to 47 cm	15.2 cm	40401D	
Adult	25 to 35 cm	12.1 cm	40401C	
Pediatric	18 to 26 cm	8.9 cm	40401B	
Infant	10 to 19 cm	6 cm	40401A	
Reusable traditional cuff kit — pediatric, adult, large adult			40400A	
Reusable traditional cuff kit — infant, pediatric, adult, large adult, thigh			40400B	

Reusable EasyCare Cuffs (Single Hose)

Patient Category/Cuff Type	Limb Circumference	Bladder Width	Part Number	Hose
Thigh	44 to 56 cm	21 cm	M4559B	M1598B (1.5m) or M1599B (3m)
Large Adult X-Long	35 to 45 cm	17 cm	M4558B	
Large Adult	35 to 45 cm	17 cm	M4557B	
Adult X-Long	27.5 to 36 cm	13.5 cm	M4556B	
Adult	27.5 to 36 cm	13.5 cm	M4555B	
Small Adult	20.5 to 28.5 cm	10.6 cm	M4554B	
Pediatric	14 to 21.5 cm	8.0 cm	M4553B	
Infant	10 to 15 cm	5.5 cm	M4552B	

Disposable Soft Adult/Pediatric Cuffs

Patient Category/Cuff Type	Limb Circumference	Bladder Width	Part Number	Hose
Thigh	44 to 56 cm	21 cm	M4579B	M1598B (1.5m) or M1599B (3m)
Large Adult X-Long	35 to 45 cm	17 cm	M4578B	
Large Adult	35 to 45 cm	17 cm	M4577B	
Adult X-Long	27.5 to 36 cm	13.5 cm	M4576B	
Adult	27.5 to 36 cm	15.5 cm	M4575B	
Small Adult	20.5 to 28.5 cm	10.6 cm	M4574B	
Pediatric	14 to 21.5 cm	8.0 cm	M4573B	
Infant	10 to 15 cm	5.5 cm	M4572B	

Disposable Adult/Pediatric Cuffs

Patient Category/Cuff Type	Limb Circumference	Bladder Width	Part Number	Hose
Thigh	42 to 54 cm	20 cm	M1879A	M1598B (1.5m) or M1599B (3m)
Large Adult	34 to 43 cm	16 cm	M1878A	
Adult	27 to 35 cm	13 cm	M1877A	
Small Adult	20.5 to 28 cm	10.5 cm	M1876A	
Pediatric	14 to 21.5 cm	8.0 cm	M1875A	
Infant	10 to 15 cm	5.5 cm	M1874A	

Disposable Neonatal Cuffs (Luer Connector)[1]

Cuffs	Limb Circumference	Bladder Width	Part Number	Hose
Size 1	3.1 to 5.7 cm	2.2 cm	M1866A	M1596B (1.5m) or M1597B (3m)
Size 2	4.3 to 8.0 cm	2.8 cm	M1868A	
Size 3	5.8 to 10.9 cm	3.9 cm	M1870A	
Size 4	7.1 to 13.1 cm	4.7 cm	M1872A	

Disposable Neonatal Cuffs (Safety Connector)[2]

Cuffs	Limb Circumference	Bladder Width	Part Number	Hose
Size 1	3.1 to 5.7 cm	2.2 cm	M1866B	M1596C (1.5m) or M1597C (3m)
Size 2	4.3 to 8.0 cm	2.8 cm	M1868B	
Size 3	5.8 to 10.9 cm	3.9 cm	M1870B	
Size 4	7.1 to 13.1 cm	4.7 cm	M1872B	
Infant Size 5	10.0 to 15 cm	5.5 cm	M1873B	

1. The luer connector cuffs and air hoses are not available in European Economic Area (EEA) countries.
2. The safety connector cuffs and air hoses may not be available in all countries. Check with your local sales organization.

IBP Accessories

Description	Part Number
Reusable pressure transducer 5µ V/V/mmHg sensitivity	CPJ840J6
Single use sterile domes (50/case)	CPJ84022

CO_2 Accessories

Intubated Circuits

Patient Category	Description	Part Number
Adult/Pediatric	FilterLine Set	M1920A
Adult/Pediatric	FilterLine H Set	M1921A
Infant/Neonatal	FilterLine H Set (can be user for humidified and non-humidified ventilation of infants)	M1923A
Adult/Pediatric	VitaLine H Set	989803159571
Infant/Neonatal	VitaLine H Set	989803159581
Adult/Pediatric	FilterLine Set Long	989803160241
Adult/Pediatric	FilterLine H Set Long	989803160251
Infant/Neonatal	FilterLine H Set Long	989803160261

Non-Intubated Dual-Purpose Circuits

Patient Category	Description	Part Number
Pediatric	Smart CapnoLine O_2, oral-nasal cannula	M2520A
Adult/Intermediate	Smart CapnoLine Plus O_2, oral-nasal cannula	M2522A
Adult	CapnoLine H O_2	M4680A
Pediatric	CapnoLine H O_2	M4681A
Pediatric	Smart CapnoLine O_2 Long	989803160271
Adult	Smart CapnoLine Plus O_2 Long	989803160281

Non-Intubated Single-Purpose Circuits

Patient Category	Description	Part Number
Pediatric	Smart CapnoLine, oral-nasal cannula	M2524A
Adult/Intermediate	Smart CapnoLine Plus, oral-nasal cannula	M2526A
Adult	CapnoLine H	M4689A
Pediatric	CapnoLine H	M4690A
Infant/Neonatal	CapnoLine H	M4691A
Adult	Smart CapnoLine Long	989803160301

Non-Intubated Ventilation, Single-Purpose Circuits

Patient Category	Description	Part Number
Adult	NIV Line	M4686A
Pediatric	NIV Line	M4687A

Temperature Accessories

Reusable Probes for the SureSigns VM6 and VM8

Description	Part Number
Esophageal/rectal probe (12 Fr)	21075A
Flexible esophageal/rectal probe (10 Fr)	21076A
Attachable skin surface probe	21078A

Disposable Probes for the SureSigns VM6 and VM8

Description	Size	Part Number	Use with this adapter
Skin surface probe	NA	21091A	21082B (1.5 m) or 21082A (3.0 m)
Esophageal/rectal probe	9 Fr	M1837A	
Esophageal/rectal probe	12 Fr	21090A	
Esophageal stethoscope probe	12 Fr	21093A	
Esophageal stethoscope probe	18 Fr	21094A	
Esophageal stethoscope probe	24 Fr	21095A	
Foley	14 Fr	M2255A	
Foley	16 Fr	21096A	
Foley	18 Fr	21097A	

Probes for the SureSigns VM4

Patient Category	Description	Part Number
All patient types	Rectal probe and well kit	989803143391
All patient types	Oral/Axillary probe and well kit	989803143381
Disposable probe covers, 1000 per case		M4823A

Miscellaneous Accessories

Description	Part Number
Roll stand with basket	989803144001
Wall mount	989803144011
Recorder paper (5 rolls)	989803136891
Lithium Ion battery	989803144631
1D barcode scanner (includes mounting arm for use with roll stand)	989803167691
2D barcode scanner (includes mounting arm for use with roll stand)	989803147821
Serial interface adapter	989803159601
Cable management kit	989803148841
USB hub, 4-port	453564039661

17
Specifications

General Specifications

SureSigns VM4 and SureSigns VM6

Parameter	Specification
Size	
Width	26 cm (10.2 in)
Height	22 cm (8.6 in)
Depth	14.5 cm (5.7 in)
Weight (excluding optional recorder and Temperature module)	3.0 kg (6.6 lbs)
Display	
Screen Type	8.4” SVGA TFT-AM LCD display
Resolution	800 active pixels/line, 600 active lines per frame
Refresh Frequency	60 Hz
Screen Active Area	170.4 x 127.8 mm (6.71 x 5.03 in)
Pixel Size	0.213 mm
Viewing Angle	± 60º
Alarm Audio Range	52 - 79 dB
System Response Time	1 second

SureSigns VM8

Parameter	Specification
Size	
Width	32 cm (12.6 in)
Height	27 cm (10.6 in)
Depth	17.5 cm (6.9 in)
Weight (excluding optional recorder and etCO2)	3.5 kg (7.7 lbs)
Display	
Screen Type	10.4” SVGA TFT-AM LCD display
Resolution	800 active pixels/line, 600 active lines per frame
Refresh Frequency	60 Hz
Screen Active Area	211.2 x 158.4 mm (8.31 x 6.24 in)
Pixel Size	0.264 mm
Viewing Angle	± 60º
Alarm Audio Range	52 - 79 dB
System Response Time	1 second

Safety Standards

Parameter	Specification
EN/IEC 60601-1, EN/IEC 60601-1-1 (as applicable), EN/IEC 60601-1-2, EN/IEC 60601-2-27, EN/IEC 60601-2-30, EN/IEC 60601-2-34, EN/IEC 60601-2-49, ISO 9919, ISO 21647	
Protection Class	Class I, internally powered equipment, per EN/IEC 60601-1
Degree of Protection	Type CF defibrillator-proof: per EN/IEC 60601-1
Mode of Operation	Continuous

Electrical Specifications

Parameter	Specification
Power Sources	
Internal Battery	Lithium ion, Smart battery 10.8 – 11.1 V 7200 mAhr
Battery Operating Time (new, fully-charged battery)	4 hours
Battery Charge Time	< 4 hours
Power Supply	Internal, 100 - 240 VAC line voltage
Power Consumption	72 Watts

Parameter	Specification
Frequency	50/60 Hz

Environmental Specifications

Caution **The monitor might not meet performance specifications if stored or used outside the specified temperature and humidity ranges.**

Parameter	Specification
Mechanical Shock	Complies with the mechanical shock requirement in ISO 9919 standards for use within the healthcare facility. Test conditions include: • Peak Acceleration: 150 m/s^2 (15.3g) • Duration: 11 ms • Pulse shape: half sine • Number of shocks: 3 shocks per direction per axis (18 total)

Parameter	Specification
Mechanical Vibration	Complies with the mechanical vibration requirement in ISO 9919 standards for use within the healthcare facility. Test conditions include: • Frequency range: 10 Hz to 2000 Hz • Resolution: 10 Hz • Acceleration amplitude: 10 Hz to 100 Hz 1,0 $(m/s^2)^2/Hz$. 100 Hz to 200 Hz -3 dB/octave 200 Hz to 2000 Hz 0.5 $(m/s^2)^2/Hz$ • Duration: 10 min per each perpendicular axis (3 total)
Thermal	
Operating Temperature	10 to 40°C (50 to 104° F)
Storage Temperature	-20 to 50°C (-4 to 122° F) for the device -20 to 40°C (-4 to 104° F) for the device plus accessories
Humidity	
Operating	Up to 80% RH, non-condensing
Storage	Up to 90% RH, non-condensing
Altitude	Up to 10,000 ft. above sea level (708 mbar)
Electromagnetic Compatibility	Meets the EN 60601-1-2:2001 standard

ECG Specifications

Parameter	Specification
Heart Rate Range	15 - 300 bpm
Heart Rate Accuracy	± 1% or ± 5 bpm (whichever is greater)
Bandwidth	Normal Monitoring: 0.15 - 40Hz Filtered Monitoring: 0.5 - 20Hz **Note —** *The SureSigns VM Series monitors comply with AAMI EC-13/IEC 60601-2-27 in Normal Monitoring mode only.*
Leads	SureSigns VM4 - 3 lead SureSigns VM6 and SureSigns VM8 - 3 lead and 5 lead, user selectable
Display Sweep Speeds	12.5, 25, and 50 mm/s
Pacemaker Detection	Indicator on waveform display, user selectable
ECG size (sensitivity)	2.0, 1.0, 0.5, 0.25 cm/mV or Auto
Lead-off Condition	Detected and displayed
Differential Input Impedance	> 2MΩ
CMRR (Common Mode Rejection Ratio)	> 86 db (with a 51 KΩ /47nF imbalance)
Input Signal Range	± 5 mV

ECG Standards

ECG Arrhythmia Supplemental Information as required by AAMI EC13	
Respiration Excitation Waveform	125 µA, 32 kHz
Time to Alarm for Tachycardia	< 5.0 seconds
Tall T-wave Rejection Capability	Exceeds ANSI/AAMI EC 13 minimum recommended 1.2 mV T-Wave amplitude
Heart Rate Averaging Method	Three different methods are used: Normally, heart rate is computed by averaging the 12 most recent RR intervals. For runs of PVCs, up to 8 RR intervals are averaged to compute the HR. If each of 3 consecutive RR intervals is greater than 1200 ms (that is, rate less than 50 bpm, 80 bpm for neonates), then the 4 most recent RR intervals are averaged to compute the HR.
Response Time of Heart Rate Meter to Change in Heart Rate	HR change from 80 to 120 bpm: Range: [6 to 10 seconds] Average: 7.4 seconds HR change from 80 to 55 bpm: Range: [7 to 8 seconds] Average: 7.2 seconds
Heart Rate Meter Accuracy and Response to Irregular Rhythm	Provides correct heart rates, as follows: Ventricular bigeminy: 80 bpm Slow alternating ventricular bigeminy: 60 bpm Rapid alternating ventricular bigeminy: 120 bpm Bidirectional systoles: 90 bpm
Accuracy of Input Signal Reproduction	Methods A and D were used to establish overall system error and frequency response.

ECG Arrhythmia Supplemental Information as required by AAMI EC13	
Time to Alarm for Cardiac Standstill	Average: 4.8 seconds
Time to Alarm for Low Heart Rate	Average: 6.6 seconds
Time to Alarm for High Heart Rate	Average: 7 seconds
Pacemaker Pulse Rejection Capability	Meets AAMI EC13 (without overshoot)

CO_2 Specifications

Parameter	Specification
Measurement Range	0 – 150 mmHg
Flow Rate	50 ml/min, + 15 ml/min, - 7.5 ml/min
CO_2 Waveform Resolution	0.1 mmHg
$etCO_2$, $imCO_2$ Resolution	1 mmHg
Initialization Time	The initialization time between turning on the monitor and presenting the first reading is typically 30 seconds; max. 3 minutes.
CO_2 Response Time	The total response time is approximately 3.9 seconds, which is calculated as follows: *Delay time + Rise time + System response time* CO_2 Delay time: 2.7 seconds CO_2 Rise time: 0.2 seconds System response time: 1.0 second **Note —** *Long FilterLines and long Smart CapnoLines add an additional 3 seconds to the overall response time.*
Calibration Interval	Initial calibration after 1,200 hours, then once per year or every 4,000 hours, whichever comes first.
Auto Zero Interval	Once per hour (typical)
Leak Tightness	< 40 mBar/min

Parameter	Specification
CO_2 Accuracy*	0 – 38 mmHg: ±2 mmHg 39 – 150 mmHg: ± (5% of reading + 0.08% for every 1 mmHg above 38 mmHg) As soon as a CO_2 reading is presented, the measurement is accurate according to the above specifications. * Accuracy applies for breath rates of up to 80 bpm. For breath rates above 80 bpm, accuracy is ± 4 mmHg or ±12% of reading, whichever is greater for etCO_2 values exceeding 18 mmHg.To achieve the specified accuracies for breath rates above 60 breaths/minute, use the FilterLine H set for Infant/Neonatal patients. The accuracy specifications is maintained to within 4% of the values indicated in the presence of interfering gases.
Drift of Measurement Accuracy	No significant drift between calibration cycles that would affect accuracy.
Respiration Rate Range	0 to 150 breaths/min
Respiration Rate Accuracy	• ±1 rpm in the range of 0 – 70 rpm • ±2 rpm in the range of 71 – 120 rpm • ±3 rpm in the range of 121 – 150 rpm
Automatic Barometric Pressure	The monitor is equipped with automatic barometric pressure compensation.
Effects of Cyclical Pressure	Will operate within specifications with over and under pressure from a ventilation system as follows: • Overpressure: +100 cmH_2O • Underpressure: -20 cmH_2O
The capnography component of this product is covered by one or more of the following US patents: 6,428,483; 6,997,880; 5,300,859, 6,437,316, 7,488,229 and their foreign equivalents. Additional patent applications pending.	

NBP Specifications

Oscillometric NBP Measurement

This monitor uses the oscillometric method for measuring NBP. In adult and pediatric mode, the blood pressure measurements determined with this device comply with the American National Standard for Electronic or Automated Sphygmomanometers (ANSI/AAMI SP10-1992) in relation to mean error and standard deviation, when compared to intra-arterial or auscultatory measurements (depending on the configuration) in a representative patient population. For the auscultatory reference, the fifth Korotkoff sound was used to determine the diastolic pressure.

In neonatal mode, the blood pressure measurements determined with this device comply with the American National Standard for Electronic or Automated Sphygmomanometers (ANSI/AAMI SP10-1992) in relation to mean error and standard deviation, when compared to intra-arterial measurements in a representative patient population. The NBP measurement is suitable for use in the presence of electrosurgery and during the discharge of a cardiac defibrillator according to IEC 601-2-30:1999/EN 60601-2-30:2000.

Oscillometric devices measure the amplitude of pressure changes in the occluding cuff as the cuff deflates from above systolic pressure. The amplitude suddenly increases as the pulse breaks through the occlusion in the artery. As the cuff pressure decreases further, the pulsations increase in amplitude, reach a maximum (which approximates to the mean pressure), and then diminish.

Studies show that, especially in critical cases (arrhythmia, vasoconstriction, hypertension, shock), oscillometric devices are more accurate and consistent than devices using other noninvasive measuring techniques.

A physician must determine the clinical significance of the NBP information.

Note — The following table lists the specifications for the Philips NBP module. For information on the specifications for a CAS NBP module, see Appendix C, “NBP Module Comparison.”

Parameter	Specification
Technique	Oscillometric using stepwise deflation pressure
Adult Measurement Range	
Systolic	30 – 270 mmHg (4.0 – 36.0 kPa)
Diastolic	10 – 245 mmHg (1.3 – 32.7 kPa)
MAP	20 – 255 mmHg (2.7 – 34.0 kPa)
Pulse Rate Range	40 – 300 bpm
Pediatric Measurement Range	
Systolic	30 – 180 mmHg (4.0 – 24.0 kPa)
Diastolic	10 – 150 mmHg (1.3 – 20.0 kPa)
MAP	20 – 160 mmHg (2.7 – 21.3 kPa)
Pulse Rate Range	40 – 300 bpm
Neonatal Measurement Range	
Systolic	30 – 130 mmHg (4.0 – 17.0 kPa)
Diastolic	10 – 100 mmHg (1.3 – 13.3 kPa)
MAP	20 – 120 mmHg (2.7 – 16.0 kPa)
Pulse Rate Range	40 - 300 bpm
Blood Pressure Accuracy	Maximum Standard Deviation: 8 mmHg Maximum Mean Error: ± 5 mmHg
Pulse Rate Accuracy	• 40 – 100 bpm: ± 5 bpm • 101 – 200 bpm: ± 5% of reading • 200 – 300 bpm: ± 10% of reading

Parameter	Specification
Initial Cuff Inflation	• Adult: 160 mmHg (21.3 kPa) • Pediatric: 140 mmHg (18.7 kPa) • Neonatal: 100 mmHg (13.3 kPa)

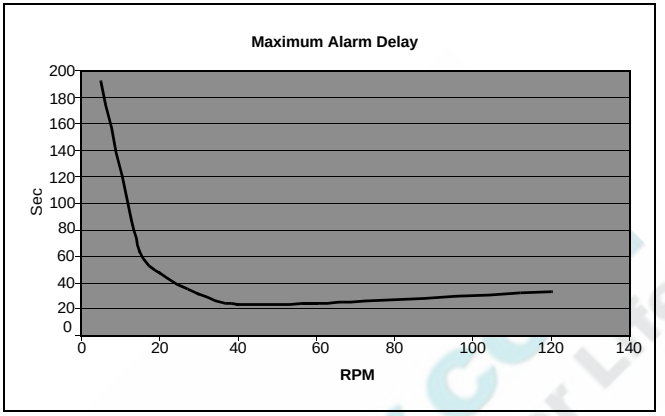
IBP Specifications

Parameter	Specification
ABP/CVP/PAP Measurement Range	-40 to 360 mmHg
Input Sensitivity	5µ V/V/mmHg
Frequency Response	dc to 40 Hz
Zero Adjustment	
Range	± 200 mmHg
Accuracy	± 1 mmHg
Gain Accuracy	
Accuracy	± 1%
Drift	less than 0.05%/^{o}C
Transducer	Load impedance: 200 to 2000 Ω Output impedance: ≤ 3000 Ω
Overall Accuracy (including transducer)	± 4% of reading or ± 4 mmHg, whichever is greater
Volume displacement of CPJ840J6	0.1 mm^{3}/100 mmHg

Impedance Respiration Specifications

Note — Applies only to impedance respiration. For SureSigns VM8 with CO_2, refer to the etCO_2 specifications.

Parameter	Specification
Technique	Trans-thoracic impedance
Measurement Range	0 - 150 respirations per minute (rpm)
Accuracy	• ± 1 rpm in the range of 0 - 120 rpm • ± 2 rpm in the range of >120 rpm
ECG Leads Used	RA to LL
Display Sweep Speeds	6.25, 12.5, 25, and 50 mm/s
Lead Off Condition	Detected and displayed
Maximum Alarm Delay	The delay of the respiration alarm after the actual RR falls outside the alarm limits depends on the difference between the RR and the limit, as well as the strength of the respiration waveform. The graph below shows the maximum delay in the case of minimum difference and low waveform strength.

Parameter	Specification
	

VM4 Temperature Specifications

Parameter	Specification
Monitored Mode Measurement Range	26.7 to 43.3°C (80 to 110°F)
Predictive Mode Measurement Range	34.4 to 40.6°C (93.9 to 105°F)
Accuracy	± 0.1 °C (± 0.2 °F) (in Monitored Mode)
Resolution	0.1°C (0.2°F)

VM6 and VM8 Temperature Specifications

Parameter	Specification
Measurement Range	25 to 45°C (77 to 113°F)
Accuracy	± 0.1 °C (± 0.2 °F)

SpO_2 Specifications

The update rate for the SpO_2 value and pulse rate is typically 1 second. Data averaging and other signal processing on the displayed and transmitted data values of SpO_2 and pulse rate is controllable by the user-selectable SpO_2 Response Mode: Slow (20 seconds), Normal (10 seconds), and Fast (5 seconds). Depending on the magnitude of difference between the alarm limit and the displayed value, the alarm signal generation delay may be from 1 second to the value of the response time (5, 10, or 20 seconds).

Because pulse oximeter equipment measurements are statistically distributed, only approximately two-thirds of pulse oximeter equipment measurements can be expected to fall within the ± Arms value measured by a CO-oximeter.

Parameter	Specification	
SpO_2 Measurement Range	0 - 100%	
Pulse Rate Measurement Range	30 - 300 bpm	
SpO_2 Accuracy[1]	Range	Accuracy
Philips Reusable Sensors		
M1191B, M1191BL, M1192A	70 - 100%	± 2%

Parameter	Specification	
M1193A, M1194A, M1195A, M1196A, M1191T, M1192T, M1196T	70 - 100%	± 3%
M1193T (Neonatal)	70 - 100%	± 4%
Philips Disposable Sensors		
M1131A, M1133A (Neonatal), M1134A (Neonatal)	70 - 100%	± 3%
M1132A, M1133A (Adult/Infant), M1134A (Adult/Infant)	70 - 100%	± 2%
Nellcor Disposable Sensors		
M1901B, M1902B, M1903B, M1904B	70 - 100%	± 3%
Pulse Rate Accuracy	2% or 1 bmp, whichever is greater	
Wavelength Range[2]	500 to 1000 nm for all specified sensors	
Maximum Optical Output Power	≤ 15mW for all specified sensors	

1. Sensor accuracy was obtained by performing controlled hypoxia studies on healthy, non-smoking adult volunteers (according to EN ISO 9919). The SpO_2 readings have been compared to CO-oximeter measurements on arterial blood samples. To represent the general population, data from at least 10 subjects (male and female) with a wide range of skin color was taken to validate SpO_2 accuracy.

2. Information about wavelength ranges can be useful for clinicians performing photodynamic therapy.

Recorder Specifications

Parameter	Specification
Type	Thermal
Paper width	58 mm
Speed	User selectable speeds of 6.25, 12.5, 25 and 50 mm/sec

Interface Specifications

Parameter	Specification
Nurse Call Alarm output	
Connector	3.5 mm phone jack, N.O and N.C contacts
Contact rating	≤ 1A, < 25VAC, < 60VDC
Isolation	1.5 kV
Delay time	< 0.5 sec
Data output	Ethernet port USB port, via the optional Serial Interface Adapter
Defib sync port	Insulated, 3 conductor, 1/4 inch phone jack. See Appendix A, “Defib Sync.”
Software upgrade	USB port
Barcode scanner connection	USB port

A
Defib Sync

This appendix describes the Defib Sync output feature, which provides a synchronization signal that some defibrillators can use to perform synchronized cardioversion.

The SureSigns VM Defib Sync port outputs a square wave synchronized to the patient's ECG R wave. The Defib Sync output is not compatible with defibrillators requiring an ECG input. If you see a square wave, instead of an ECG wave, on your defibrillator display, the devices are not compatible.

Warning **To meet AAMI specifications, the peak of the synchronized defibrillator discharge should be delivered within 60 ms of the peak of the R wave. Your biomedical engineer must verify that your ECG/Defibrillator combination does not exceed the recommended maximum delay of 60 ms.**

Before using the system for cardioversion, ensure that your biomedical engineer tests the monitor and defibrillator together and trains users on the appropriate use of the Defib Sync system.

Improper operation can result in harm to the patient.

Connecting to the Defib Sync Port

Defib Sync port

The following figure shows the location of the Defib Sync signal output port on the rear panel of the monitor.

Your biomed or other service person must make a Defib Sync interface cable. Use the specifications listed below to create a cable to interface between the monitor and the defibrillator.

The 1/4-inch Defib Sync output port has three contacts:

- Tip — Sync pulse output signal +
- Ring — Sync pulse output signal +
- Sleeve (barrel) — Sync pulse output signal –

The following table contains the specifications for the Defib Sync output signal.

Parameter	Specification
Signal level	0 to 5V pulse
Pulse width	100 ± 10 ms
Delay from R-wave peak to start of pulse	35 ms, maximum, per AAMI EC 13
Maximum allowable sync current	4 mA

B
Alarm Specifications

This appendix contains an alphabetical listing of physiological and technical alarm messages. It also contains a table of factory default alarm limits and the calculations used for the Auto Set Alarm Limits option.

Physiological Alarms

The following table contains an alphabetical listing of physiological alarm messages.

Alarm Message	Priority	Cause
ABP(D) High	Medium	The Diastolic ABP value has exceeded the high alarm limit.
ABP(D) Low	Medium	The Diastolic ABP has dropped below the low alarm limit.
ABP(M) High	Medium	The MAP ABP value has exceeded the high alarm limit.
ABP(M) Low	Medium	The MAP ABP value has dropped below the low alarm limit.
ABP(S) High	Medium	The Systolic ABP value has exceeded the high alarm limit.
ABP(S) Low	Medium	The Systolic ABP value has dropped below the low alarm limit.
Asystole	High	No QRS has been detected for 4 seconds.

Alarm Message	Priority	Cause
awRR Apnea	High	Respiration has not been detected for longer than the time specified in the **awRR Apnea Alarm** field.
CVP High	Medium	The CVP value has exceeded the high alarm limit.
CVP Low	Medium	The CVP value has dropped below the low alarm limit.
etCO2 High	Medium	The $etCO_2$ value has exceeded the high alarm limit.
etCO2 Low	Medium	The $etCO_2$ value has dropped below the low alarm limit.
HR = RR	Low	If both the Heart Rate and Respiration Rate are derived from ECG, and the Heart Rate value is approximately the same as the Respiration value, the **HR = RR** alarm sounds to indicate that the Respiration value may be unreliable. Reposition the ECG electrodes. For more information, see the Cardiac Overlay section in "Optimizing ECG Lead Placement for Respiration Measurements" on page 10-2.
HR High	Medium	The heart rate value has exceeded the high alarm limit.
HR Low	Medium	The heart rate value has dropped below the low alarm limit.
imCO2 High	Medium	The inspired CO_2 value has exceeded the high alarm limit.
NBP(D) High	Medium	The Diastolic NBP value has exceeded the high alarm limit.
NBP(D) Low	Medium	The Diastolic NBP value has dropped below the low alarm limit.
NBP(M) High	Medium	The MAP NBP value has exceeded the high alarm limit.
NBP(M) Low	Medium	The MAP NBP value has dropped below the low alarm limit.

Alarm Message	Priority	Cause
NBP(S) High	Medium	The Systolic NBP value has exceeded the high alarm limit.
NBP(S) Low	Medium	The Systolic NBP value has dropped below the low alarm limit.
Pacer Non-Capture	Medium	A missed beat with a pace pulse was detected (paced patients only)
Pacer Not Pacing	Medium	A missed beat without a pace pulse was detected (paced patients only).
PAP(D) High	Medium	The Diastolic PAP value has exceeded the high alarm limit.
PAP(D) Low	Medium	The Diastolic PAP value has dropped below the low alarm limit.
PAP(M) High	Medium	The MAP PAP value has exceeded the high alarm limit.
PAP(M) Low	Medium	The MAP PAP value has dropped below the low alarm limit.
PAP(S) High	Medium	The Systolic PAP value has exceeded the high alarm limit.
PAP(S) Low	Medium	The Systolic PAP value has dropped below the low alarm limit.
PVC/min High	Medium	Premature ventricular contractions per minute has exceeded the high alarm limit.
Resp Apnea	High	Respiration has not been detected for longer than the time specified in the **RESP Apnea Alarm** field.
Resp Rate High	Medium	The respiration value has exceeded the high alarm limit.
Resp Rate Low	Medium	The respiration value has dropped below the low alarm limits.

Alarm Message	Priority	Cause
SpO2 Desat	High	A high-priority alarm that alerts you to a potentially life-threatening drop in oxygen saturation. The **SpO2 Desat** alarm sounds when the SpO_2 value is 10 less than the current low limit for adults and pediatric patients and 5 less for neonates.
SpO2 High	Medium	The SpO_2 value has exceeded the high alarm limit.
SpO2 Low	Medium	The SpO_2 value has dropped below the low alarm limit.
Temp High	Low	The temperature value has exceeded the high alarm limit.
Temp Low	Low	The temperature value has dropped below the low alarm limit.
Vent Rhythm	Medium	A dominant rhythm of adjacent ventricular ectopic beats exceeds the vent rhythm limit and ventricular HR is below the VTach HR limit.
Vent Run	Medium	Based on the specified VT Rate and a VT Count between 3 and the specified VT Count minus 1.
V-Fib	High	A fibrillatory waveform persists for more than 4 seconds.
V-Tach	High	Based on the VT Rate and VT Count specified in the Heart Rate Menu.

Technical Alarms

The following table contains an alphabetical listing of technical alarm messages

Alarm Message	Priority	Cause
ABP Equip Malfunc	Low	ABP equipment malfunction. See your system administrator to check the error log for details.
ABP Non-pulsatile	Medium	The ABP waveform is less than 3 mmHg (0.4 kPa) for 4 seconds. Check the catheter and connections to the patient.
ABP No Transducer	Low	The ABP transducer is not connected.
ABP Out of Range	Low	The ABP value is outside the ABP measurement range.
CO2 Auto Zero	Low	The CO_2 Auto Zero is in progress.
CO2 Calibration Needed	Low	The CO_2 module should be calibrated after 1,200 hours of operation. After the first calibration, calibrate once a year, or after 4,000 hours, whichever comes first.
CO2 Equip Malfunc	Low	CO_2 equipment malfunction. See your system administrator to check the error log for details.
CO2 No Tubing	High	The CO_2 filter line is not connected.
CO2 Occlusion	Low	The sampling line or exhaust tube is blocked. The CO_2 pump will stop drawing the air sample into the monitor for analysis. Disconnect and reconnect the sampling line. If the message still appears, replace the sampling line with a new one. The pump will resume operation when the new sampling line is connected or the occlusion is cleared.
CO2 Out of Range	Low	The CO_2 value is outside the CO_2 measurement range.
CO2 Purging	Low	The CO_2 filter line is being purged to remove an occlusion in the line or airway adapter. If the occlusion is removed, the message disappears.

Alarm Message	Priority	Cause
CVP Equip Malfunc	Low	CVP equipment malfunction. See your system administrator to check the error log for details.
CVP No Transducer	Low	The CVP transducer is not connected.
CVP Out of Range	Low	The CVP value is outside the CVP measurement range.
Date / Time Adjusted	Low	Indicates that a time change greater than 30 seconds occurred when the monitor synchronized the time to the server. This alarm can occur only if your system administrator enables the **Synchronize Time** option on the **Data Export Menu**, or if you synchronize the clock on the monitor with the VSV.
ECG Equip Malfunc	Low	The ECG hardware internal calibration failed. See your system administrator to check the error log for details.
ECG Leads Off	Low	Not all the required leads for ECG monitoring are connected. Check the ECG connections and make sure that the electrodes are attached.
Extreme Low Batt	High	This is the second low battery alarm. Remaining battery power is less than 21%.
Low Batt	Low	Remaining battery power is less than 30%.
Loss of Monitoring	Low	Indicates that the monitor has shut itself down and then rebooted, due to an internal error. The **Loss of Monitoring** message appears to inform you that some patient data may have been lost.
NBP Air Leak	Low	The monitor cannot adjust pressure. This may be due to leakage or an internal NBP module problem.

Alarm Message	Priority	Cause
NBP Artifact	Low	The monitor cannot correct the pressure to the intended value within the time limit, or the monitor requires too many pressure correction attempts to adjust the pressure to the intended value. This may be due to excessive patient movement, leakage, or a problem with extreme edematous patients.
NBP Equip Malfunc	Low	NBP equipment malfunction. See your system administrator to check the error log for details.
NBP Hose Blocked	Low	The monitor has detected a defect in the pneumatic system, such as valves, hose, or plug.
NBP Loose Cuff	Low	The NBP cuff cannot inflate to the target value within the limits of the selected patient size. May be caused by a pump defect, leakage, or disconnected cuff.
NBP Out of Range	Low	The NBP value is outside the NBP measurement range.
NBP Overpressure	High	The NBP cuff pressure exceeds the overpressure safety limits: • 300 mmHg (40.0 kPa) for adult/pediatric patients • 150 mmHg (20.0 kPa) for neonatal patients This error is caused by a sudden rise in pressure if the cuff is squeezed or bumped. The monitor cannot take any more NBP readings until the alarm is acknowledged.
NBP Timeout	Low	The NBP cuff deflation lasts longer than the limits of the selected patient size, or the measurement time exceeded 180 seconds for adult/pediatric patients and 90 seconds for neonatal patients. This may be due to extreme bradycardia or excessive artifacts.

Alarm Message	Priority	Cause
NBP Weak Signal	Low	The monitor could not derive a blood pressure measurement. This may be due to excessive artifacts, extremely weak pulse signal, incorrect patient size setting, or the blood pressure measurement is out of range.
No Central Monitoring	Low	If the monitor is networked, it is no longer communicating with the VSV.
PAP Equip Malfunc	Low	PAP equipment malfunction. See your system administrator to check the error log for details.
PAP Non-pulsatile	Medium	The PAP waveform is less than 3 mmHg (0.4 kPa) for 4 seconds. Check the catheter and connections to the patient.
PAP No Transducer	Low	The PAP transducer is not connected.
PAP Out of Range	Low	The PAP value is outside the PAP measurement range.
Recorder Door Open	Low	The recorder door is open and must be closed to work properly.
Recorder Not Installed	Low	The optional recorder is not installed in your monitor.
Recorder Out of Paper	Low	The recorder is out of paper.
Speaker Malfunc	Low	Malfunction of the speaker. See your system administrator. This is a visual alarm only. **Note —** *The* **Speaker Malfunc** *message is only available if the main board in your VM monitor is version 5 or greater. To determine which main board is installed in your monitor, see "Changing System Settings" on page 2-26.*
SpO2 Equip Malfunc	Low	SpO_2 equipment malfunction. See your system administrator to check the error log for details.

Alarm Message	Priority	Cause
SpO2 Erratic	Low	Erratic SpO_2 measurement. Often due to a faulty sensor, incorrect application, or incorrect positioning of sensor.
SpO2 Extd Update	Low	The update period of the displayed SpO_2 value is extended because an NBP measurement is being taken on the same limb, or because of an excessively noisy signal.
SpO2 Interference	Low	The level of ambient light or electrical interference is so high that it prevents SpO_2/pulse rate from being measured reliably.
SpO2 Low Perf	Low	SpO_2 accuracy may be compromised due to very low perfusion.
SpO2 No Sensor	High	The SpO_2 sensor cable is disconnected from the monitor.
SpO2 Noisy Signal	Low	Excessive patient movement or electrical interference is causing irregular pulse patterns.
SpO2 Non-Pulsatile	High	Pulse is too weak for the algorithm to detect the physiological pulse or the sensor is no longer attached to the patient.
SpO2 Sensor Malfunc	Low	Malfunction of the SpO_2 sensor or sensor cable. See your system administrator to check the error log for details.
Temp Equip Malfunc	Low	Temperature equipment malfunction on the SureSigns VM6 or VM8 monitor. See your system administrator to check the error log for details.

Alarm Message	Priority	Cause
Temp Module Malfunc	Low	The temperature module has malfunctioned. If the malfunction is caused by electrostatic discharge on the temperature probe, you can reset the temperature module and clear the error by inserting the probe in the probe well and pulling it out. If the error message is not cleared after you insert the probe in the probe well and pull it out, the malfunction may be caused by one of the following: • Battery or power-supply voltage not in range • Ambient temperature too high • Ambient temperature too low See your system administrator to check the error log for details.
Temp Out of Range	Low	The temperature value is outside the temperature measurement range.
Temp Probe Disconnect	Low	The temperature probe has become disconnected.
Temp Probe Error	Low	Temperature probe error. If the malfunction is caused by electrostatic discharge on the temperature probe, you can reset the temperature module and clear the error by inserting the probe in the probe well and pulling it out. If the error message is not cleared after you insert the probe in the probe well and pull it out, the malfunction may be caused by one of the following: • The probe well is missing • The probe well is not installed properly • The probe warmer has overheated See your system administrator to check the error log for details.

Factory Default Alarm Limits and Alarm Ranges

This section lists the default alarm limits and the alarm limit ranges for all physiological alarms.

Factory Default Alarm Limits

The following table lists the default alarm limits that are set in the factory.

Note — Your system administrator can change these factory defaults to different default values.

	Adult		Pediatric		Neonatal	
	High	**Low**	**High**	**Low**	**High**	**Low**
ABP Diastolic	90 mmHg (12.0 kPa)	50 mmHg (6.7 kPa)	70 mmHg (9.3 kPa)	40 mmHg (5.3 kPa)	60 mmHg (8.0 kPa)	20 mmHg (2.7 kPa)
ABP MAP	110 mmHg (14.7 kPa)	70 mmHg (9.3 kPa)	90 mmHg (12.0 kPa)	50 mmHg (6.7 kPa)	70 mmHg (9.3 kPa)	35 mmHg (4.7 kPa)
ABP Systolic	160 mmHg (21.3 kPa)	90 mmHg (12.0 kPa)	120 mmHg (16.0 kPa)	70 mmHg (9.3 kPa)	90 mmHg (12.0 kPa)	55 mmHg (7.3 kPa)
CVP	10 mmHg (1.3 kPa)	0 mmHg (0.0 kPa)	4 mmHg (0.5 kPa)	0 mmHg (0.0 kPa)	4 mmHg (0.5 kPa)	0 mmHg (0.0 kPa)
$etCO_2$	50 mmHg (6.7 kPa)	30 mmHg (4.0 kPa)	50 mmHg (6.7 kPa)	30 mmHg (4.0 kPa)	50 mmHg (6.7 kPa)	30 mmHg (4.0 kPa)
HR (ECG)	120 bpm	50 bpm	160 bpm	75 bpm	200 bpm	100 bpm
HR (SpO_2)	120 bpm	50 bpm	160 bpm	75 bpm	200 bpm	100 bpm
HR (NBP)	120 bpm	50 bpm	160 bpm	75 bpm	200 bpm	100 bpm

	Adult		Pediatric		Neonatal	
	High	**Low**	**High**	**Low**	**High**	**Low**
imCO$_2$	4 mmHg (0.5 kPa)	NA	4 mmHg (0.5 kPa)	NA	4 mmHg (0.5 kPa)	NA
NBP Diastolic	90 mmHg (12.0 kPa)	50 mmHg (6.7 kPa)	70 mmHg (9.3 kPa)	40 mmHg (5.3 kPa)	60 mmHg (8.0 kPa)	20 mmHg (2.7 kPa)
NBP MAP	110 mmHg (14.7 kPa)	70 mmHg (9.3 kPa)	90 mmHg (12.0 kPa)	50 mmHg (6.7 kPa)	70 mmHg (9.3 kPa)	24 mmHg (3.2 kPa)
NBP Systolic	160 mmHg (21.3 kPa)	90 mmHg (12.0 kPa)	120 mmHg (16.0 kPa)	70 mmHg (9.3 kPa)	90 mmHg (12.0 kPa)	40 mmHg (5.3 kPa)
PAP Diastolic	16 mmHg (2.1 kPa)	0 mmHg (0.0 kPa)	4 mmHg (0.5 kPa)	–4 mmHg (–0.5 kPa)	4 mmHg (0.5 kPa)	–4 mmHg (–0.5 kPa)
PAP MAP	20 mmHg (2.7 kPa)	0 mmHg (0.0 kPa)	26 mmHg (3.5 kPa)	12 mmHg (1.6 kPa)	26 mmHg (3.5 kPa)	12 mmHg (1.6 kPa)
PAP Systolic	35 mmHg (4.7 kPa)	10 mmHg (1.3 kPa)	60 mmHg (8.0 kPa)	24 mmHg (3.2 kPa)	60 mmHg (8.0 kPa)	24 mmHg (3.2 kPa)
PVC	10 PVC/ min	NA	5 PVC/min	NA	5 PVC/min	NA
Respiration	30 rpm	8 rpm	30 rpm	8 rpm	100 rpm	30 rpm
SpO$_2$	100%	90%	100%	90%	95%	85%
Temperature	102.2°F (39°C)	96.8°F (36°C)	102.2°F (39°C)	96.8°F (36°C)	102.2°F (39°C)	96.8°F (36°C)

Alarm Limit Ranges

The following table lists the user-adjustable ranges for all physiological alarms.

	Adult Alarm Range	Pediatric Alarm Range	Neonatal Alarm Range
ABP Diastolic High	55 - 359 mmHg (7.3 - 47.9 kPa)	45 - 359 mmHg (6.0 - 47.9 kPa)	22 - 359 mmHg (2.9 - 47.9 kPa)
ABP Diastolic Low	–39 - 85 mmHg (–5.2 - 11.3 kPa)	–39 - 65 mmHg (–5.2 - 8.7 kPa)	–39 - 55 mmHg (–5.2 - 7.3 kPa)
ABP MAP High	75 - 359 mmHg (10.0 - 47.9 kPa)	55 - 359 mmHg (7.3 - 47.9 kPa)	40 - 359 mmHg (5.3 - 47.9 kPa)
ABP MAP Low	–39 - 105 mmHg (–5.2 - 14.0 kPa)	–39 - 85 mmHg (–5.2 - 11.3 kPa)	–39 - 65 mmHg (–5.2 - 8.7 kPa)
ABP Systolic High	95 - 359 mmHg (12.7 - 47.9 kPa)	75 - 359 mmHg (10.0 - 47.9 kPa)	60 - 359 mmHg (8.0 - 47.9 kPa)
ABP Systolic Low	–39 - 155 mmHg (–5.2 - 20.7 kPa)	–39 - 145 mmHg (–5.2 - 19.3 kPa)	–39 - 85 mmHg (–5.2 - 11.3 kPa)
CVP High	2 - 359 mmHg (0.3 - 47.9 kPa)	2 - 359 mmHg (0.3 - 47.9 kPa)	2 - 359 mmHg (0.3 - 47.9 kPa)
CVP Low	–39 - 8 mmHg (–5.2 - 1.1kPa)	–39 - 2 mmHg (–5.2 - 0.3 kPa)	–39 - 2 mmHg (–5.2 - 0.3 kPa)
$etCO_2$ High	**CO2-O** module: 32 - 98 mmHg (4.3 - 13.1 kPa)	**CO2-O** module: 32 - 98 mmHg (4.3 - 13.1 kPa)	**CO2-O** module: 32 - 98 mmHg (4.3 - 13.1 kPa)
	CO2-S module: 32 - 149 mmHg (4.3 - 19.9 kPa)	**CO2-S** module: 32 - 149 mmHg (4.3 - 19.9 kPa)	**CO2-S** module: 32 - 149 mmHg (4.3 - 19.9 kPa)

	Adult Alarm Range	Pediatric Alarm Range	Neonatal Alarm Range
$etCO_2$ Low	1 - 70 mmHg (0.1 - 9.3 kPa)	1 - 75 mmHg (0.1 - 10 kPa)	1 - 75 mmHg (0.1 - 10 kPa)
HR (ECG) High	55 - 299 bpm	80 -299 bpm	80 - 299 bpm
HR (ECG) Low	16 - 115 bpm	16 - 155 bpm	16 - 195 bpm
HR (SpO_2) High	55 - 299 bpm	80 -299 bpm	80 - 299 bpm
HR (SpO_2) Low	31 - 115 bpm	31 - 155 bpm	31 - 195 bpm
HR (NBP) High	55 - 239 bpm	80 -239 bpm	80 - 239 bpm
HR (NBP) Low	41 - 115 bpm	41 - 155 bpm	41 - 195 bpm
$imCO_2$ High	2 - 20 mmHg (0.3 - 2.7 kPa)	2 - 20 mmHg (0.3 - 2.7 kPa)	2 - 20 mmHg (0.3 - 2.7 kPa)
$imCO_2$ Low	NA	NA	NA
NBP Diastolic High	55 - 244 mmHg (7.3 - 32.5 kPa)	55 - 149 mmHg (7.3 - 19.9 kPa)	22 - 99 mmHg (2.9 - 13.2 kPa)
NBP Diastolic Low	11 - 85 mmHg (1.5 - 11.3 kPa)	11 - 65 mmHg (1.5 - 8.7 kPa)	11 - 55 mmHg (1.5 - 7.3 kPa)
NBP MAP High	65 - 254 mmHg (8.7 - 33.9 kPa)	55 - 159 mmHg (7.3 - 21.2 kPa)	26 - 119 mmHg (3.5 - 15.9 kPa)
NBP MAP Low	21 - 105 mmHg (2.8 - 14.0 kPa)	21 - 85 mmHg (2.8 - 11.3 kPa)	21 - 65 mmHg (2.8 - 8.7 kPa)
NBP Systolic High	95 - 269 mmHg (12.7 - 35.9 kPa)	75 - 179 mmHg (10.0 - 23.9 kPa)	45 - 129 mmHg (6.0 - 17.2 kPa)
NBP Systolic Low	31 - 155 mmHg (4.1 - 20.7 kPa)	31 - 120 mmHg (4.1 - 16.0 kPa)	31 - 85 mmHg (4.1 - 11.3 kPa)

	Adult Alarm Range	Pediatric Alarm Range	Neonatal Alarm Range
PAP Diastolic High	–2 - 359 mmHg (–0.3 - 47.9 kPa)	–2 - 359 mmHg (–0.3 - 47.9 kPa)	–2 - 359 mmHg (–0.3 - 47.9 kPa)
PAP Diastolic Low	–39 - 14 mmHg (–5.2 - 1.9 kPa)	–39 - 2 mmHg (–5.2 - 0.3 kPa)	–39 - 2 mmHg (–5.2 - 0.3 kPa)
PAP MAP High	2 - 359 mmHg (0.3 - 47.9 kPa)	14 - 359 mmHg (1.9 - 47.9 kPa)	14 - 359 mmHg (1.9 - 47.9 kPa)
PAP MAP Low	–39 - 18 mmHg (–5.2 - 2.4 kPa)	–39 - 24 mmHg (–5.2 - 3.2 kPa)	–39 - 24 mmHg (–5.2 - 3.2 kPa)
PAP Systolic High	12 - 359 mmHg (1.6 - 47.9 kPa)	26 - 359 mmHg (3.5 - 47.9 kPa)	26 - 359 mmHg (3.5 - 47.9 kPa)
PAP Systolic Low	–39 - 30 mmHg (–5.2 - 4.0 kPa)	–39 - 55 mmHg (–5.2 - 7.3 kPa)	–39 - 55 mmHg (–5.2 - 7.3 kPa)
PVC High	1 - 99 PVC/min	1 - 99 PVC/min	1 - 99 PVC/min
Respiration High	10 - 149 rpm	10 - 149 rpm	35 - 149 rpm
Respiration Low	4 - 25 rpm	4 - 25 rpm	4 - 95 rpm
SpO_2 High	50 - 100%	50 - 100%	31 - 100%
SpO_2 Low	0 - 99%	0 - 99%	0 - 99%
Temperature High (VM6 and VM8 only)	96.9 - 112.8°F (36.1 - 44.9°C)	96.9 - 112.8°F (36.1 - 44.9°C)	96.9 - 112.8°F (36.1 - 44.9°C)
Temperature Low (VM6 and VM8 only)	77.2 - 102.0°F (25.1 - 38.9°C)	77.2 - 102.0°F (25.1 - 38.9°C)	77.2 - 102.0°F (25.1 - 38.9°C)

Auto Set Alarms

This section contains the formulas used for calculating Auto Set Alarm Limits. The first table contains the Adult and Pediatric calculations and the second table contains the Neonatal calculations. For information on applying Auto Set Alarm Limits see “Setting Customized Alarm Limits” on page 3-11.

If the calculated offset value exceeds the alarm limit range, the system does not change the upper and lower alarm limits.

For some limits, especially Neonatal, the auto set limits are clamped. This means that the calculated limits stay at a fixed value, regardless of the measured value. For example, the Auto Set calculation for Neonatal low heart rate is:

HR – 30 (within 80 - 100 bpm)

If the measured heart rate value is 90 bpm, the monitor calculates the value:

90 – 30 = 60 bpm

The monitor then determines that 60 bmp is outside the safe limits (80 to 100 bpm), so the new alarm limit is changed to 80.

Adult/Pediatric Auto Set Alarm Calculations

Parameter	Adult/Pediatric Low Limit	Adult/Pediatric High Limit
ABP Diastolic	Diastolic x 0.68 + 6 mmHg (Diastolic x 0.68 + 0.8 kPa)	Diastolic x 0.86 + 32 mmHg (Diastolic x 0.86 + 4.3 kPa)
ABP MAP	MAP x 0.68 + 8 mmHg (MAP x 0.68 + 1.1 kPa)	MAP x 0.86 + 35 mmHg (MAP x 0.86 + 4.7 kPa)
ABP Systolic	Systolic x 0.68 + 10 mmHg (Systolic x 0.68 + 1.3 kPa)	Systolic x 0.86 + 38 mmHg (Systolic x 0.86 + 5.1 kPa)
CVP Mean	Mean – 4 mmHg (within – 2 - 4 mmHg) Mean – 0.5 kPa (within – 0.3 - 0.5 kPa)	Mean + 4 mmHg (within 10 - 20 mmHg) Mean + 0.5 kPa (within 1.3 - 2.7 kPa)
$etCO_2$	• 0 - 32 mmHg (0 - 4.3 kPa) — No change • 32 - 35 mmHg (4.3 - 4.7 kPa) — 29 mmHg (3.9 kPa) • 35 - 45 mmHg (4.7 - 6.0 kPa) — $etCO_2$ – 6 mmHg ($etCO_2$ – 0.8 kPa) • 45 - 48 mmHg (6.0 - 6.4 kPa) — 39 mmHg (5.2 kPa) • > 48 mmHg (6.4 kPa) — No change	• 0 - 32 mmHg (0 - 4.3 kPa) — No change • 32 - 35 mmHg (4.3 - 4.7 kPa) — 41 mmHg (5.5 kPa) • 35 - 45 mmHg (4.7 - 6.0 kPa) — $etCO_2$ + 6 mmHg ($etCO_2$ + 0.8 kPa) • 45 - 48 mmHg (6.0 - 6.4 kPa) — 51 mmHg (6.8 kPa) • > 48 mmHg (6.4 kPa) — No change
HR (ECG)	HR x 0.8 or 16 bpm (whichever is greater)	HR x 1.25 or 299 bpm (whichever is smaller)
HR (SpO_2)	HR x 0.8 or 31 bpm (whichever is greater)	HR x 1.25 or 299 bpm (whichever is smaller)

Parameter	Adult/Pediatric Low Limit	Adult/Pediatric High Limit
HR (NBP)	HR x 0.8 or 41 bpm (whichever is greater)	HR x 1.25 or 239 bpm (whichever is smaller)
imCO$_2$	No change	20 mmHg (3.0 kPa)
NBP Diastolic	Diastolic x 0.68 + 6 mmHg (Diastolic x 0.68 + 0.8 kPa)	Diastolic x 0.86 + 32 mmHg (Diastolic x 0.86 + 4.3 kPa)
NBP MAP	MAP x 0.68 + 8 mmHg MAP x 0.68 + 1.1 kPa	MAP x 0.86 + 35 mmHg MAP x 0.86 + 4.7 kPa
NBP Systolic	Systolic x 0.68 + 10 mmHg Systolic x 0.68 + 1.3 kPa	Systolic x 0.86 + 38 mmHg Systolic x 0.86 + 5.1 kPa
PAP Diastolic	Diastolic – 6 mmHg (within 0 - 4 mmHg) Diastolic – 0.8 kPa (within 0 - 0.5 kPa)	Diastolic + 6 mmHg (within 10 - 24 mmHg) Diastolic + 0.8 kPa (within 1.3 - 3.2 kPa)
PAP MAP	MAP – 6 mmHg (within 0 - 8 mmHg) MAP – 0.8 kPa (within 0 - 1.1 kPa)	MAP + 6 mmHg (within 20 - 28 mmHg) MAP + 0.8 kPa (within 2.7 - 3.7 kPa)
PAP Systolic	Systolic – 6 mmHg (within 10 - 16 mmHg) Systolic – 0.8 kPa (within 1.3 - 2.1 kPa)	Systolic + 10 mmHg (within 35 - 45 mmHg) Systolic + 1.3 kPa (within 4.7 - 6.0 kPa)
Respiration (CO$_2$)	awRR x 0.5 or 4/min (whichever is greater)	awRR x 1.5 or 30/min (whichever is smaller)
Respiration (ECG)	RR x 0.5 or 4/min (whichever is greater)	RR x 1.5 or 30/min (whichever is smaller)
SpO$_2$	Same as default alarm limit	Same as default alarm limit

Parameter	Adult/Pediatric Low Limit	Adult/Pediatric High Limit
Temperature	Temp – 0.9°F (Temp – 0.5°C)	Temp + 0.9°F (Temp + 0.5°C)

Neonatal Auto Set Alarm Calculations

The following table lists the formulas used for calculating Auto Set Alarm Limits for Neonatal patients.

Parameter	Neonatal Low Limit	Neonatal High Limit
ABP Diastolic	Diastolic – 15 mmHg (within 20 - 40 mmHg) Diastolic – 2 kPa (within 2.7 - 5.3 kPa)	Diastolic + 15 mmHg (within 55 - 75 mmHg) Diastolic + 2 kPa (within 7.3 - 10.0 kPa)
ABP MAP	MAP – 15 mmHg (within 35 - 45 mmHg) MAP – 2 kPa (within 4.7 - 6.0 kPa)	MAP + 15 mmHg (within 65 - 75 mmHg) MAP + 2 kPa (within 8.7 - 10.0 kPa)
ABP Systolic	Systolic – 15 mmHg (within 45 - 60 mmHg) Systolic – 2 kPa (within 6.0 - 8.0 kPa)	Systolic + 15 mmHg (within 90 - 115 mmHg) Systolic + 2 kPa (within 12.0 - 15.3 kPa)
CVP Mean	Mean – 3 mmHg (within 0 - 4 mmHg) Mean – 0.4 kPa (within 0 - 0.5 kPa)	Mean + 4 mmHg (within 6 - 10 mmHg) Mean + 0.5 kPa (within 0.8 - 1.3 kPa)

Parameter	Neonatal Low Limit	Neonatal High Limit
$etCO_2$	• 0 - 32 mmHg (0 - 4.3 kPa) — No change • 32 - 35 mmHg (4.3 - 4.7 kPa) — 29 mmHg (3.9 kPa) • 35 - 45 mmHg (4.7 - 6.0 kPa) — $etCO_2$ – 6 mmHg ($etCO_2$ – 0.8 kPa) • 45 - 48 mmHg (6.0 - 6.4 kPa) — 39 mmHg (5.2 kPa) • > 48 mmHg (6.4 kPa) — No change	• 0 - 32 mmHg (0 - 4.3 kPa) — No change • 32 - 35 mmHg (4.3 - 4.7 kPa) — 41 mmHg (5.5 kPa) • 35 - 45 mmHg (4.7 - 6.0 kPa) — $etCO_2$ + 6 mmHg ($etCO_2$ + 0.8 kPa) • 45 - 48 mmHg (6.0 - 6.4 kPa) — 51 mmHg (6.8 kPa) • > 48 mmHg (6.4 kPa) — No change
Heart Rate	HR – 30 (within 80 - 100 bpm)	HR + 40 (within 180 - 210 bpm)
$imCO_2$	NA	20 mmHg (3.0 kPa)
NBP Diastolic	Diastolic – 15 mmHg (within 20 - 40 mmHg) Diastolic – 2 kPa (within 2.7 - 5.3 kPa)	Diastolic + 15 mmHg (within 55 - 75 mmHg) Diastolic + 2 kPa (within 7.3 - 10.0 kPa)
NBP MAP	MAP – 15 mmHg (within 35 - 45 mmHg) MAP –2 kPa (within 4.7 - 6.0 kPa)	MAP + 15 mmHg (within 65 - 75 mmHg) MAP +2 kPa (within 8.7 - 10.0 kPa)
NBP Systolic	Systolic – 15 mmHg (within 45 - 60 mmHg) Systolic – 2 kPa (within 6.0 - 8.0 kPa)	Systolic + 15 mmHg (within 90 - 115 mmHg) Systolic + 2 kPa (within 12.0 - 15.3 kPa)

Parameter	Neonatal Low Limit	Neonatal High Limit
PAP Diastolic	Diastolic – 3 mmHg (within –4 - 0 mmHg) Diastolic – 0.4 kPa (within –0.5 - 0 kPa)	Diastolic + 3 mmHg (within 2 - 6 mmHg) Diastolic + 0.4 kPa (within 0.3 - 0.8 kPa)
PAP MAP	MAP – 8 mmHg (within 6 - 18 mmHg) MAP – 1.1 kPa (within 0.8 - 2.4 kPa)	MAP + 8 mmHg (within 28 - 40 mmHg) MAP + 1.1 kPa (within 3.7 - 5.3 kPa)
PAP Systolic	Systolic – 8 mmHg (within 12 - 22 mmHg) Systolic – 1.1 kPa (within 1.6 - 2.9 kPa)	Systolic + 10 mmHg (within 35 - 60 mmHg) Systolic + 1.3 kPa (within 4.7 - 8.0 kPa)
Respiration (CO_2)	awRR – 50 (within 25 - 40)	awRR + 25 (within 75 - 95)
Respiration (ECG)	RR – 50 (within 25 - 40)	RR + 25 (within 75 - 95)
SpO_2	Same as default alarm limit	Same as default alarm limit
Temperature	Temp – 0.9°F (Temp – 0.5°C)	Temp + 0.9°F (Temp + 0.5°C)

C
NBP Module Comparison

Overview

This appendix provides additional information about non-invasive blood pressure (NBP) modules in SureSigns monitors.

SureSigns monitors may contain either a Philips NBP or CAS NBP hardware module. The procedures to measure NBP are the same whether the monitor contains a Philips NBP module or a CAS NBP module. However, because monitors in your care area may each contain different NBP modules, you should be aware of these differences:

- Conditions that cause NBP technical alarm messages
- NBP measurement limits that, if exceeded, result in physiological alarms
- NBP specifications
- Initial NBP inflation pressure adjustment ranges

You can determine whether your monitor contains a Philips NBP module or a CAS NBP module by looking at the **Configuration** settings in the **System Menu**. If the monitor contains a Philips NBP module, the Configuration setting includes the text **NBP-P**; if the monitor contains a CAS NBP module, the Configuration setting includes the text **NBP-C**.

Technical NBP Alarm Messages

The following table lists the technical NBP alarm messages generated by the monitor and the condition that causes each message for a Philips or CAS NBP module. The messages are listed in alphabetical order.

	Philips NBP Module	CAS NBP Module
Alarm	**Condition**	**Condition**
NBP Air Leak	The monitor cannot adjust pressure. This may be due to leakage or an internal NBP module problem.	An air leak has occurred in the pneumatics, hose, or cuff.
NBP Artifact	The monitor cannot correct the pressure to the intended value within the time limit, or the monitor requires too many pressure correction attempts to adjust the pressure to the intended value. This may be due to excessive patient movement, leakage, or a problem with extreme edematous patients.	May be caused by any of the following: • Too many retries due to interference or motion artifact. • The signal is too noisy during step-down to detect pressure. • A highly irregular pulse rate, for example, arrhythmia. Or: Another form of motion that induces electronic hardware problems; for example, a large signal that causes the blood pressure amplifier to not handle amplitude.

	Philips NBP Module	CAS NBP Module
Alarm	**Condition**	**Condition**
NBP Equip Malfunction	NBP equipment malfunction. See your system administrator to check the error log for details.	The Power-on self test failed. May be caused by: • A/D converter inoperative. • Pressure transducer offset is too large. • System failure due to abnormal, unrecoverable errors because of internal firmware code execution. For example, a stack overflow, divide by 0, and so on. See your system administrator to check the error log for details.
NBP Hose Blocked	The monitor has detected a defect in the pneumatic system, such as valves, hose, or plug.	The monitor cannot maintain stable cuff pressure. May be due to a kinked hose.
NBP Loose Cuff	The NBP cuff cannot inflate to the target value within the limits of the selected patient size. May be caused by a pump defect, leakage, or disconnected cuff.	May be caused by any of the following: • A large cuff is completely unwrapped. • No increase in cuff pressure is detected. • No cuff is attached.
NBP Out of Range	The NBP value is outside the NBP measurement range.	The NBP value is outside the NBP measurement range.

	Philips NBP Module	CAS NBP Module
Alarm	**Condition**	**Condition**
NBP Overpressure	The NBP cuff pressure exceeds the overpressure safety limits: • 300 mmHg (40.0 kPa) for adult/ pediatric patients • 150 mmHg (20.0 kPa) for neonatal patients This error is caused by a sudden rise in pressure if the cuff is squeezed or bumped. The monitor cannot take any more NBP readings until the alarm is acknowledged.	The NBP cuff pressure exceeds the overpressure safety limits: • 290 mmHg (38.7 kPa) for adult/ pediatric patients • 145 mmHg (19.3 kPa) for neonatal patients This error is caused by a sudden rise in pressure if the cuff is squeezed or bumped. The monitor cannot take any more NBP readings until the alarm is acknowledged.
NBP Timeout	The NBP cuff deflation lasts longer than the limits of the selected patient size, or the measurement time exceeded 180 seconds for adult/ pediatric patients and 90 seconds for neonatal patients. This may be due to extreme bradycardia or excessive artifacts.	The measurement time exceeds 120 seconds for adult/pediatric patients and 90 seconds for neonatal patients.
NBP Weak Signal	The monitor could not derive a blood pressure measurement. This may be due to excessive artifacts, extremely weak pulse signal, incorrect patient size setting, or the blood pressure measurement is out of range.	The NBP signal is weak because of a loosely wrapped cuff and/or an extremely weak pulse from patient.
NBP Wrong Cuff Size	***Note:*** *The NBP Wrong Cuff Size alarm does not occur if the monitor has a Philips NBP module.*	A neonatal blood pressure cuff was detected, but the current patient type is Adult.

Physiological NBP Alarm Limits

The following table lists the user-adjustable ranges for physiological NBP alarms using Philips and CAS NBP modules:

	Philips NBP Alarm Range			CAS NBP Alarm Range		
	Adult	**Pediatric**	**Neonatal**	**Adult**	**Pediatric**	**Neonatal**
NBP Diastolic High	55 - 244 mmHg (7.3 - 32.5 kPa)	55 - 149 mmHg (7.3 - 19.9 kPa)	22 - 99 mmHg (2.9 - 13.2 kPa)	55 - 219 mmHg (7.3 - 29.2 kPa)	55 - 219 mmHg (7.3 - 29.2 kPa)	22 - 109 mmHg (2.9 - 14.5 kPa)
NBP Diastolic Low	11 - 85 mmHg (1.5 - 11.3 kPa)	11 - 65 mmHg (1.5 - 8.7 kPa)	11 - 55 mmHg (1.5 - 7.3 kPa)	16 - 85 mmHg (2.1 - 11.3 kPa)	16 - 65 mmHg (2.1 - 8.7 kPa)	16 - 55 mmHg (2.1 - 7.3 kPa)
NBP MAP High	65 - 254 mmHg (8.7 - 33.9 kPa)	55 - 159 mmHg (7.3 - 21.2 kPa)	26 - 119 mmHg (3.5 - 15.9 kPa)	65 - 234 mmHg (8.7 - 31.2 kPa)	55 - 234 mmHg (7.3 - 31.2 kPa)	26 - 124 mmHg (3.5 - 16.5 kPa)
NBP MAP Low	21 - 105 mmHg (2.8 - 14.0 kPa)	21 - 85 mmHg (2.8 - 11.3 kPa)	21 - 65 mmHg (2.8 - 8.7 kPa)	21 - 105 mmHg (2.8 - 14.0 kPa)	21 - 85 mmHg (2.8 - 11.3 kPa)	21 - 65 mmHg (2.8 - 8.7 kPa)
NBP Systolic High	95 - 269 mmHg (12.7 - 35.9 kPa)	75 - 179 mmHg (10.0 - 23.9 kPa)	45 - 129 mmHg (6.0 - 17.2 kPa)	95 - 254 mmHg (12.7 - 33.9 kPa)	75 - 254 mmHg (10.0 - 33.9 kPa)	45 - 134 mmHg (6.0 - 17.9 kPa)
NBP Systolic Low	31 - 155 mmHg (4.1 - 20.7 kPa)	31 - 120 mmHg (4.1 - 16.0 kPa)	31 - 85 mmHg (4.1 - 11.3 kPa)	31 - 155 mmHg (4.1 - 20.7 kPa)	31 - 120 mmHg (4.1 - 16.0 kPa)	31 - 85 mmHg (4.1 - 11.3 kPa)

NBP Specifications

The following table lists the specifications for Philips and CAS NBP modules:

	Philips NBP Module	CAS NBP Module
Parameter	**Specification**	**Specification**
Standard	NBP conforms to ANSI/AAMI SP10 1992	NBP conforms to ANSI/AAMI SP10 EN 1060-3
Technique	Oscillometric using stepwise deflation pressure	
Adult Measurement Range		
Systolic	30 - 270 mmHg (4.0 - 36.0 kPa)	30 - 255 mmHg (4.0 - 34.0 kPa)
Diastolic	10 - 245 mmHg (1.3 - 32.7 kPa)	15 - 220 mmHg (2.0 - 29.0 kPa)
MAP	20 - 255 mmHg (2.7 - 34.0 kPa)	20 - 235 mmHg (2.7 - 31.3 kPa)
Pulse Rate Range	40 - 300 bpm	30 - 240 bpm
Pediatric Measurement Range		
Systolic	30 - 180 mmHg (4.0 - 24.0 kPa)	30 - 255 mmHg (4.0 - 34.0 kPa)
Diastolic	10 - 150 mmHg (1.3 - 20.0 kPa)	15 - 220 mmHg (2.0 - 29.0 kPa)
MAP	20 - 160 mmHg (2.7 - 21.3 kPa)	20 - 235 mmHg (2.7 - 31.3 kPa)
Pulse Rate Range	40 - 300 bpm	30 - 240 bpm
Neonatal Measurement Range		
Systolic	30 - 130 mmHg (4.0 - 17.0 kPa)	30 - 135 mmHg (4.0 - 18.0 kPa)
Diastolic	10 - 100 mmHg (1.3 - 13.3 kPa)	15 - 110 mmHg (2.0 - 14.7 kPa)
MAP	20 - 120 mmHg (2.7 - 16.0 kPa)	20 - 125 mmHg (2.7 - 16.7 kPa)
Pulse Rate Range	40 - 300 bpm	40 - 240 bpm
Blood Pressure Accuracy	Maximum Standard Deviation: 8 mmHg Maximum Mean Error: ± 5 mmHg	± 5 mmHg (0.7 kPa)

	Philips NBP Module	CAS NBP Module
Parameter	**Specification**	**Specification**
Pulse Rate Accuracy	40 - 100 bpm: ± 5 bpm 101 - 200 bpm: ± 5% of reading 201 - 300 bpm: ± 10% of reading	± 2 bpm or ± 2% (whichever is greater)
Initial Cuff Inflation	Adult: 160 mmHg (21.3 kPa) Pediatric: 140 mmHg (18.7 kPa) Neonatal: 100 mmHg (13.3 kPa)	Adult: 160 mmHg (21.3 kPa) Pediatric: 140 mmHg (18.7 kPa) Neonatal: 100 mmHg (13.3 kPa)
Subsequent Cuff Inflation (in NBP Interval mode only)	The subsequent inflation pressure is determined automatically, depending on the previous measurement and patient type.	30 mmHg (4.0 kPa) above the last Systolic value

Initial NBP Inflation Pressure Adjustment Ranges

The system administrator specifies the initial NBP cuff inflation pressure for each patient type. The following table lists the adjustment ranges for each patient type:

Patient Type	Philips NBP Module	CAS NBP Module
Adult	100 - 280 mmHg in 10 mmHg steps (13.3 - 37.3 kPa in 1.3 kPa steps)	80 - 240 mmHg in 20 mmHg steps (10.7 - 32.0 kPa in 2.7 kPa steps)
Pediatric	100 - 190 mmHg in 10 mmHg steps (13.3 - 25.3 kPa in 1.3 kPa steps)	80 - 240 mmHg in 20 mmHg steps (10.7 - 32.0 kPa in 2.7 kPa steps)
Neonatal	100 - 140 mmHg in 10 mmHg steps (13.3 - 18.7 kPa in 1.3 kPa steps)	60 - 120 mmHg in 20 mmHg steps (8.0 - 16.0 kPa in 2.7 kPa steps)

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D
Electromagnetic Compatibility

This appendix lists the tests and compliance levels that make the SureSigns VM Series patient monitors suitable for use in the specified electromagnetic environment according to IEC 60601-1-2:2001.

Instructions for Use

Medical electrical equipment can either generate or receive electromagnetic interference. This product has been evaluated for electromagnetic compatibility (EMC) with the appropriate accessories according to IEC 60601-1-2:2001, the international standard for EMC for medical electrical equipment. This IEC standard has been adopted in the European Union as the European Norm, EN 60601-1-2:2001.

Radio frequency (RF) interference from nearby transmitting devices can degrade performance of the product. Electromagnetic compatibility with surrounding devices should be assessed prior to using the product.

Fixed, portable, and mobile radio frequency communications equipment can also affect the performance of medical equipment. See your service provider for assistance with the minimum recommended separation distance between RF communications equipment and the product.

The cables, sensors/transducers, and other accessories for which compliance is claimed are listed in this manual.

Warning

- **Use of accessories, transducers, and cables other than those specified may result in increased emissions and/or decreased immunity of the SureSigns VM Series patient monitors.**
- **The SureSigns VM Series patient monitors should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the monitor should be observed to verify normal operation in the configuration in which it is used.**

Reducing Electromagnetic Interference

The SureSigns VM Series patient monitors and associated accessories can be susceptible to interference from other RF energy sources and continuous, repetitive, power line bursts. Examples of other sources of RF interference are other medical electrical devices, cellular products, information technology equipment, and radio/television transmission. If interference is encountered, as demonstrated by artifact on the ECG or dramatic variations in physiological parameter measurement values, attempt to locate the source. Assess the following:

- Is the interference due to misplaced or poorly applied electrodes or sensors? If so, re-apply electrodes and sensors correctly according to directions in the product's *Instructions for Use*.
- Is the interference intermittent or constant?
- Does the interference occur only in certain locations?
- Does the interference occur only when in close proximity to certain medical electrical equipment?
- Do parameter measurement values change dramatically when the AC line cord is unplugged?

Once the source is located, attempt to attenuate the interference by distancing the product from the source as much as possible. If assistance is needed, contact your local service representative.

Restrictions for Use

Artifact on ECG and other physiological waveforms caused by electromagnetic interference should be evaluated by a physician or physician authorized personnel to determine if it will negatively impact patient diagnosis or treatment.

Emissions and Immunity

The SureSigns VM Series patient monitors are designed and evaluated to comply with the emissions and immunity requirements of international and national EMC standards. For detailed information regarding declaration and guidance, see Table D-1 through Table D-4.

The EMC standards state that manufacturers of patient-coupled equipment must specify immunity levels for their systems. See Table D-2 and Table D-3 for this detailed immunity information. See Table D-4 for recommended minimum separation distances between portable and mobile communications equipment and the product.

Immunity is defined in the standard as the ability of a system to perform without degradation in the presence of an electromagnetic disturbance. Degradation in system performance is a qualitative assessment which can be subjective.

Caution should, therefore, be taken in comparing immunity levels of different devices. The criteria used for degradation is not specified by the standard and can vary with the manufacturer.

Guidance and Manufacturer's Declaration

The SureSigns VM Series patient monitors are intended for use in the electromagnetic environment specified in the following tables. The customer or the user of the product should verify that it is used in such an environment.

Table D-1. Electromagnetic Emissions

Emissions Test	Compliance	Electromagnetic Environment Guidance
RF emissions CISPR 11	Group 1	The SureSigns VM Series patient monitors use RF energy only for their internal function. Therefore, RF emissions are very low and not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The SureSigns VM Series patient monitors are suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

Table D-2. Electromagnetic Immunity (ESD, EFT, Surge, Dips and Magnetic Field)

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	± 1 kV differential mode ±2 kV common mode	± 1 kV ±1 kV	In the event of reduced performance, it may be necessary to operate the patient monitor from a filtered power connection or battery powered (no electrical connection to the AC mains while monitoring.)
Surge IEC 61000-4-5	± 1 kV differential mode ± 2 kV common mode	± 1 kV ± 2 kV	Mains power quality should be that of a typical commercial and/or hospital environment.
Voltage dips, short interruptions, and voltage variations on power supply input lines IEC 61000-4-11	< 5% U_T (> 95% dip in U_T) for 0,5 cycle 40% U_T (60% dip in U_T) for 5 cycles 70% U_T (30% dip in U_T) for 25 cycles < 5% U_T (> 95% dip in U_T) for 5 sec	< 5% U_T 40% U_T 70% U_T < 5% U_T	

Table D-2. Electromagnetic Immunity (ESD, EFT, Surge, Dips and Magnetic Field)

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
Power frequency (50/60 Hz) Magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
Note — *U_T is the AC mains voltage prior to application of the test level.*			

Table D-3. Electromagnetic Immunity (RF Radiated and Conducted)

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
			Portable and mobile RF communications equipment should be used no closer to any part of the SureSigns VM Series patient monitors, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Conducted RF IEC 61000-4-6	3 Vrms 0.15 to 80 MHz Outside ISM bands	3 V rms	Recommended Separation Distance $d = \left[\frac{3.5}{3}\right]\sqrt{P}$; 0.150 to 80 MHz

Table D-3. Electromagnetic Immunity (RF Radiated and Conducted)

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
Radiated RF IEC 61000-4-3	3 V/m 80 to 2500 MHz	3 V/m	$d = \left[\frac{3.5}{3}\right]\sqrt{P}$; 80 to 800 MHz $d = \left[\frac{7}{3}\right]\sqrt{P}$; 800 to 2500 MHz where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,[a] should be less than the compliance level in each frequency range.[b] Interference may occur in the vicinity of equipment marked with the following symbol: 

Table D-3. Electromagnetic Immunity (RF Radiated and Conducted)

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the SureSigns VM patient monitor is used exceeds the applicable RF compliance level above, the SureSigns VM patient monitor should be observed to verify normal operation. If abnormal performance is observed, additional measures are necessary, such as re-orienting or relocating the SureSigns VM patient monitor.

[b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m. Respiration measurement may be subject to interference at 900 - 1100 kHz and 70 - 80 MHz at less than 3 V/M field strength.

Recommended Separation Distances

The SureSigns VM Series patient monitors are intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the product can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the product as recommended below, according to the maximum output power of the communications equipment.

Table D-4. Recommended Separation Distances Between Portable and Mobile RF Communication Equipment and the SureSigns VM Patient Monitor

Frequency of Transmitter	150 kHz to 80 MHz	80 to 800 MHz	800 MHz to 2.5 GHz
Equation	$d = \left[\frac{3.5}{3}\right]\sqrt{P}$	$d = \left[\frac{3.5}{3}\right]\sqrt{P}$	$d = \left[\frac{7}{3}\right]\sqrt{P}$
Rated Maximum Output Power of Transmitter (Watts)	Separation Distance (d) (meters)	Separation Distance (d) (meters)	Separation Distance (d) (meters)
0.01	0.12	0.12	0.23

Table D-4. Recommended Separation Distances Between Portable and Mobile RF Communication Equipment and the SureSigns VM Patient Monitor

Frequency of Transmitter	**150 kHz to 80 MHz**	**80 to 800 MHz**	**800 MHz to 2.5 GHz**
Equation	$d = \left[\frac{3.5}{3}\right]\sqrt{P}$	$d = \left[\frac{3.5}{3}\right]\sqrt{P}$	$d = \left[\frac{7}{3}\right]\sqrt{P}$
Rated Maximum Output Power of Transmitter (Watts)	**Separation Distance (d) (meters)**	**Separation Distance (d) (meters)**	**Separation Distance (d) (meters)**
0.1	0.37	0.37	0.74
1	1.17	1.17	2.33
10	3.69	3.69	7.38
100	11.67	11.67	23.33

For transmitters rated at a maximum output power not listed above, the separation distance *d* can be estimated, in meters, using the equation in the corresponding column, where *P* is the maximum output power rating of the transmitter in watts according to the transmitter's manufacturer.

These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Index

D

E

F

G

H

I

L

M

N

O

P

R

S

T

V

W

Z